

A BIBLIOGRAPHY OF APPLICATIONS OF OPERATIONAL RESEARCH IN SUB-SAHARAN AFRICA

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ABSTRACT. There continues to be considerable interest in the potential for applying Operational Research in less-developed countries. A recent paper provided a bibliography of published research from West Africa. This paper extends that bibliography to the other sub-Saharan nations, with the omission of South Africa. In some parts of this region, there have been numerous applications described in the literature, while in others there is very little on record. As in the earlier paper, the material has been collected from a wide range of journals, extending from the regular O.R. literature to many application journals. In addition to the references, the paper describes the manner of collection of this information, and discusses the resulting picture of O.R. in sub-Saharan Africa.

1. INTRODUCTION

In 2008, the author published a bibliography of papers relating to applications of Operational Research (O.R.) in 18 countries of West Africa [302]. This paper complements that bibliography, by applying the same principles to identifying the O.R.-related literature for the remaining nations of mainland sub-Saharan Africa, with the exception of South Africa. Apart from Madagascar (Malagasy Republic), the African islands in the Indian and Atlantic Oceans have been excluded. The Mediterranean nations of North Africa do not feature in this work. The decision to restrict the scope of this second bibliography was on the basis of a sense of homogeneity in development, even though there is considerable diversity in many other aspects of the nations — government, history, climate, relations with the developed world, and so on.

As in the earlier work, the intention of this paper is to provide a collection of published literature that is as complete as possible. The two papers may then form the foundation of future studies of the possibility and reality of using O.R. in each of the countries studied.

2. COMPILATION

As has been explained earlier, the scope of this paper is those less-developed sub-Saharan African nations which were not included in [302]. These countries are listed later in the paper. (Table 2) Many are former colonies of the European powers (United Kingdom, France, Spain, Belgium, Portugal, Italy and Germany) and retain cultural and linguistic links with their colonial power. But any student of twentieth century history will be aware that independence from European administration has not proceeded smoothly, and several of the countries discussed have seen revolutions and civil wars, sometime needing intervention from the United Nations, the Organization of African Unity or another external agency. Most, if not all, of the countries listed in this paper are recipients of overseas aid from the governments of developed nations and also from charities, relief agencies and other non-governmental organizations. Sometimes staff associated with the donor countries or organizations have used O.R. in their work and published an account of that. Generally, though, the pressures on the time and energy of

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such men and women preclude publication in the academic literature. Accordingly, much experience of the use of O.R. in developing countries is unpublished, and known only to those involved.

Aggarwal [4] was employed to study various O.R. problems in Somalia, one of the countries discussed below. In his account of working in that country, he pointed out that the concept of O.R. in developing countries is different from that found in the developed world. The term ‘‘O.R.’’ may not be used to describe the approach being taken. It is more common for research workers to refer to a particular quantitative technique such as mixed integer programming or multi-criteria analysis than to use the term ‘‘O.R.’’. It might be argued that this shows a positive attitude towards problem solving; researchers know that a model has to be built, and the tool-bag of O.R. methodology provides a technique. On the other hand, the user may neither recognise that other methodologies exist, nor be aware of the approach and philosophy of the O.R. scientist. So, it is easy for such one-off interventions to be seen as the only way that models can be built. Further, decision-makers have different assumptions from those familiar in ‘‘traditional’’ O.R. methodology. Aggarwal makes the comment: ‘‘The primary objective pursued in each case was to make the situation tolerable for as many people as possible.’’

With Aggarwal’s comment in mind, the scope of this bibliography was determined to be papers which describe a case-study or a practical example of O.R. in a country, part of a country, or several countries, and which develops methodology for

- (1) ‘‘What if?’’ questions **or**
- (2) ‘‘Science of Better’’ questions

either of which may make the situation being studied ‘‘more tolerable’’.

The papers in the bibliography may describe a practical application or they may describe analysis after some event. There are comparatively few reports which present details of implementation. Whether or not these papers are accounts of an implementation, practically all have used field data.

2.1. Sources of information about published papers. As in the earlier paper, the author used a variety of sources, to compile this bibliography. The principal ones, as before, were

- International Abstracts in Operations Research;
- Google Scholar
- ISI Web of Science
- Previous bibliographies
- Online databases provided by publishers

and the merits and demerits of each are discussed there.

3. THE EVIDENCE

Topic	count	Topic	count	Topic	count
Agriculture	134	Malaria	9	Education	4
Health	60	Nutrition	9	Environment	4
Water	42	Government	8	Tourism	3
Forestry	29	Land resources	8	Waste management	3
Energy	20	Veterinary work	7	Emergencies	2
Economics	19	Food	6	Industry	2
Conservation	12	Location	6	Planning	2
Transport	12	Mining	6	Relief	2
Development	11	Finance	5	Pollution	1
Society	11	Communications	4		

TABLE 1. Frequency of papers devoted to topics

The bibliography contains over 300 papers. What is the nature of these, and how are they distributed? Future researchers may be concerned about what problems have been considered (the topics) and what country or countries the work relates to. The combination of topic and country may also be relevant to some studies.

Classification of the material is, in several cases, an ad hoc process. However, there are many common themes across the papers. The major topics are self-evident as being of priority for the government and people of less-developed countries. The minor topics identified are often associated with these major ones, but it has seemed appropriate to identify particular subjects. Table 1 shows the count of papers by topics. Agriculture is the most common subject that is modelled. Given the nature of the countries, this is not surprising. Nor is it surprising that health is ranked immediately below. The bibliography excludes several papers which model the epidemiology of HIV/AIDS in Africa. Although such models are mathematical in nature, they have not been included because their purpose is enlightenment and explanation rather than action.

There is considerable variation between the economies of the countries included here. The bibliography includes references to subsistence agriculture and to the operation of national stock exchanges.

Table 2 shows the count by countries. In both tables, the total number of papers in the bibliography is less than the total in the tables because several papers have been classified under several topics or make reference to more than one country. The association of a paper with a country is generally on the basis that there is a reference to the country in the paper's title, abstract or list of key-words. A few papers have no national association, as they refer to models and problems in several, unspecified, sub-Saharan countries. Because one might expect larger countries to feature in more papers, Table 3 shows the number of papers per country divided by the square root of the population, and then mapped to the range (0, 100). This table may be described as a measure of the impact of O.R. in the countries.

Finally, Table 4 shows the growth of the number of publications with time. This indicates, as one might expect, that there is a steady increase in the number of papers being published. One hopes that there is a similar increase in the application of O.R. methodology.

One other feature deserves comment. Reference has already been made to the colonial powers which governed much of sub-Saharan Africa until the middle of the twentieth century. It will be seen that in both Table 2 and Table 3, the highest ranked nations are those which were part of the British Empire, and most remain part of the British Commonwealth. This bias towards English-speaking nations is significant. It may be that the use of the English language as the means of international research communication makes it more difficult to publish work by those whose first language is not English. It may be that English-speaking researchers from developed countries gravitate to collaborate with researchers who speak the same language. It may be that there is less research work being carried out in those countries which were governed by other European powers. It may be that the countries with lower ranks have had more civil instability since independence than the others. All four explanations are credible, and the answer is probably a combination of these four causes. In order to try and be fair to all countries, wherever possible, the searches which have given rise to this bibliography were conducted in international databases, searching in a manner which located the terms in the major European languages.

4. COUNTRIES

In this section, we simply list the papers in the bibliography, classified by country and area of relevance. We have included, for completeness, those countries for which no research papers have been found. The number following the section title shows the number of papers listed.

4.1. **Angola(6).**

4.1.1. *Emergencies.* [76]

4.1.2. *Government.* [71]

Country	Papers	Country	Papers	Country	Papers
Tanzania	63	Mozambique	13	Swaziland	4
Kenya	54	Sudan	10	Equatorial Guinea	2
Zambia	26	Namibia	9	Somalia	2
Ethiopia	24	Chad	7	Djibouti	1
Zimbabwe	24	Angola	6	Lesotho	1
Malawi	17	Eritrea	6	Rep. Congo (Brazzaville)	1
Uganda	17	Madagascar	5	Burundi	0
Botswana	14	Rwanda	5	Western Sahara	0
D R Congo (formerly Zaire)	13	Central A R	4		

TABLE 2. Frequency of papers which refer to particular countries.

Country	measure	Country	measure	Country	measure
Botswana	100	Eritrea	27	Angola	14
Tanzania	95	Ethiopia	27	Djibouti	11
Kenya	85	Mozambique	27	Madagascar	11
Zambia	72	Equatorial Guinea	24	Lesotho	7
Zimbabwe	68	Chad	21	Somalia	7
Namibia	61	Central A R	19	Rep. Congo (Brazzaville)	5
Malawi	43	D R Congo (formerly Zaire)	16	Burundi	0
Swaziland	37	Rwanda	16	Western Sahara	0
Uganda	30	Sudan	15		

TABLE 3. Measure of impact of O.R. on the countries; the number of papers from Table 2 divided by the square root of the population and scaled to the range 0 to 100

Years	Count of articles
—1970	1
1971—1975	9
1976—1980	6
1981—1985	17
1986—1990	26
1991—1995	31
1996—2000	45
2001—2005	69
2006—2010	112

TABLE 4. The number of articles in the bibliography, by year

4.1.3. *Health*. [181]

4.1.4. *Mining*. [287]

4.1.5. *Relief*. [76]

4.1.6. *Tourism*. [31]

4.1.7. *Water*. [178]

4.2. **Botswana(14).**

- 4.2.1. *General*. [68], [216]
- 4.2.2. *Agriculture*. [96], [158], [218], [226]
- 4.2.3. *Conservation*. [29], [158], [226]
- 4.2.4. *Economics*. [218]
- 4.2.5. *Energy*. [103]
- 4.2.6. *Food*. [96]
- 4.2.7. *Health*. [66], [224], [290], [322]
- 4.2.8. *Water*. [136], [178]
- 4.3. Central African Republic (Centrafrique)(4).**
- 4.3.1. *Agriculture*. [332]
- 4.3.2. *Development*. [43]
- 4.3.3. *Environment*. [42]
- 4.3.4. *Forestry*. [275], [332]
- 4.4. Chad(7).**
- 4.4.1. *Agriculture*. [69], [195], [245]
- 4.4.2. *Health*. [6], [22], [113], [331]
- 4.4.3. *Water*. [245]
- 4.5. Congo (Brazzaville)(1).**
- 4.5.1. *Health*. [143]
- 4.6. Congo (Zaire)(13).**
- 4.6.1. *Agriculture*. [11], [12], [13], [14], [225]
- 4.6.2. *Economics*. [225]
- 4.6.3. *Forestry*. [333]
- 4.6.4. *Health*. [77],[133], [143], [227], [278], [344]
- 4.6.5. *Malaria*. [36]
- 4.6.6. *Transport*. [225]
- 4.7. Djibouti(1).**
- 4.7.1. *Agriculture*. [58]
- 4.8. Equatorial Guinea (Guinea Ecuatorial)(2).**
- 4.8.1. *Agriculture*. [332]
- 4.8.2. *Environment*. [42]
- 4.8.3. *Forestry*. [332]

4.9. Eritrea(6).

4.9.1. *Agriculture.* [58], [294], [310]

4.9.2. *Energy.* [126]

4.9.3. *Government.* [294]

4.9.4. *Health.* [304]

4.9.5. *Land Resources.* [310]

4.9.6. *Malaria.* [342]

4.9.7. *Water.* [126]

4.10. Ethiopia(24).

4.10.1. *Agriculture.* [7], [20], [58], [80], [86], [95], [116], [119], [122], [127], [130], [168], [169], [170], [268], [286], [329], [341]

4.10.2. *Conservation.* [170]

4.10.3. *Economics.* [20], [95], [122]

4.10.4. *Energy.* [118]

4.10.5. *Finance.* [20]

4.10.6. *Food.* [116], [154]

4.10.7. *Forestry.* [26]

4.10.8. *Government.* [154]

4.10.9. *Health.* [340]

4.10.10. *Land Resources.* [329], [341]

4.10.11. *Water.* [97], [119], [130], [235], [329]

4.11. Kenya(54).

4.11.1. *Agriculture.* [21], [41], [48], [58], [98], [105], [115], [144], [145], [160], [176], [179], [180], [187], [196], [231], [232], [253], [254], [258], [259], [284], [305], [316], [318], [325], [326], [335]

4.11.2. *Communications.* [64], [65], [327]

4.11.3. *Conservation.* [187]

4.11.4. *Development.* [41], [63], [104]

4.11.5. *Economics.* [5], [21], [56], [82], [238]

4.11.6. *Energy.* [149], [234], [244], [270]

4.11.7. *Finance.* [5] [56], [125]

4.11.8. *Forestry.* [117], [259], [261], [318], [326]

4.11.9. *Government.* [82]

4.11.10. *Health.* [66], [109], [182], [183], [238], [277]

- 4.11.11. *Industry*. [63]
- 4.11.12. *Land Resources*. [86], [105]
- 4.11.13. *Malaria*. [109]
- 4.11.14. *Marketing*. [335]
- 4.11.15. *Nutrition*. [21]
- 4.11.16. *Society*. [21], [105]
- 4.11.17. *Tourism*. [28]
- 4.11.18. *Water*. [115], [179], [180], [255], [260], [305]
- 4.12. **Lesotho(1)**.
- 4.12.1. *Health*. [51]
- 4.13. **Madagascar(5)**.
- 4.13.1. *Agriculture*. [306]
- 4.13.2. *Conservation*. [3]
- 4.13.3. *Education*. [222]
- 4.13.4. *Forestry*. [3], [337]
- 4.13.5. *Transport*. [153]
- 4.14. **Malawi(17)**.
- 4.14.1. *Agriculture*. [10], [15], [35], [74], [84], [85], [251], [266], [292], [311], [312]
- 4.14.2. *Economics*. [56]
- 4.14.3. *Finance*. [10], [56]
- 4.14.4. *Food*. [15]
- 4.14.5. *Forestry*. [189], [311], [312]
- 4.14.6. *Health*. [66], [74], [312], [314], [338]
- 4.14.7. *Nutrition*. [74], [102]
- 4.14.8. *Society*. [10], [311]
- 4.14.9. *Transport*. [251]
- 4.14.10. *Water*. [266]
- 4.15. **Mozambique(13)**.
- 4.15.1. *Agriculture*. [251]
- 4.15.2. *Communication*. [60]
- 4.15.3. *Conservation*. [46]
- 4.15.4. *Energy*. [49], [162]

- 4.15.5. *Environment*. [46]
- 4.15.6. *Forestry*. [189], [246]
- 4.15.7. *Health*. [67], [156], [319],
- 4.15.8. *Malaria*. [67]
- 4.15.9. *Transport*. [251]
- 4.15.10. *Tourism*. [46]
- 4.15.11. *Water*. [83], [142]
- 4.16. **Namibia(9)**.
 - 4.16.1. *Agriculture*. [57], [96]
 - 4.16.2. *Conservation*. [271]
 - 4.16.3. *Development*. [203]
 - 4.16.4. *Environment*. [300]
 - 4.16.5. *Food*. [96]
 - 4.16.6. *Health*. [37]
 - 4.16.7. *Planning*. [203]
 - 4.16.8. *Water*. [136], [155], [178]
- 4.17. **Rwanda(5)**.
 - 4.17.1. *Agriculture*. [247], [321]
 - 4.17.2. *Conservation*. [321]
 - 4.17.3. *Forestry*. [211]
 - 4.17.4. *Health*. [338]
 - 4.17.5. *Nutrition*. [247]
 - 4.17.6. *Water*. [148]
- 4.18. **Somalia(2)**.
 - 4.18.1. *Agriculture*. [4], [58]
 - 4.18.2. *Development*. [4]
 - 4.18.3. *Economics*. [4]
 - 4.18.4. *Education*. [4]
 - 4.18.5. *Food*. [4]
 - 4.18.6. *Industry*. [4]
 - 4.18.7. *Nutrition*. [4]
 - 4.18.8. *Waste management*. [4]

4.19. Sudan(10).

4.19.1. *Agriculture.* [47], [58], [94], [99], [130], [298]

4.19.2. *Development.* [47]

4.19.3. *Education.* [47]

4.19.4. *Emergencies.* [34]

4.19.5. *Energy.* [233]

4.19.6. *Forestry.* [94], [139], [233], [298]

4.19.7. *Land resources.* [8], [298]

4.19.8. *Relief.* [34]

4.19.9. *Veterinary work.* [47]

4.19.10. *Water.* [8], [47], [99], [130]

4.20. Swaziland(4).

4.20.1. *Agriculture.* [93]

4.20.2. *Education.* [184]

4.20.3. *Health.* [184]

4.20.4. *Transport.* [93]

4.20.5. *Water.* [83], [293]

4.21. Tanzania(63).

4.21.1. *General.* [175]

4.21.2. *Agriculture.* [4], [25], [87], [88], [138], [163], [166], [202], [207], [228], [264], [279], [289], [291], [294], [295], [296], [315], [323],

4.21.3. *Conservation.* [120], [334]

4.21.4. *Development.* [4], [138], [272]

4.21.5. *Economics.* [4], [129], [161], [272]

4.21.6. *Education.* [4], [223]

4.21.7. *Energy.* [200], [239], [240], [283], [320],[336]

4.21.8. *Environment.* [213]

4.21.9. *Forestry.* [9], [117], [166], [188], [220], [228], [291]

4.21.10. *Government.* [135], [294], [295]

4.21.11. *Health.* [52], [53], [66], [108], [110], [111], [112], [143], [152], [186], [190], [198], [199], [221], [262]

4.21.12. *Location.* [108], [269], [339]

4.21.13. *Malaria.* [190], [198], [199]

4.21.14. *Mining.* [323],

- 4.21.15. *Nutrition.* [4], [296]
- 4.21.16. *Planning.* [135]
- 4.21.17. *Pollution.* [283]
- 4.21.18. *Society.* [120], [129], [166]
- 4.21.19. *Transport.* [72], [213], [241], [269]
- 4.21.20. *Waste management.* [4], [263], [297], [339]
- 4.21.21. *Water.* [141], [161], [163], [164], [166], [264], [279], [282]
- 4.22. **Uganda(17).**
 - 4.22.1. *Agriculture.* [58], [121], [137], [217], [265], [274]
 - 4.22.2. *Development.* [40]
 - 4.22.3. *Economics.* [243]
 - 4.22.4. *Energy.* [54], [55]
 - 4.22.5. *Forestry.* [243]
 - 4.22.6. *Government.* [40]
 - 4.22.7. *Health.* [32], [92], [167], [288], [301]
 - 4.22.8. *Nutrition.* [137], [217]
 - 4.22.9. *Society.* [243]
 - 4.22.10. *Water.* [185], [309]
- 4.23. **Zambia(26).**
 - 4.23.1. *Agriculture.* [96], [146], [147], [251], [328]
 - 4.23.2. *Conservation.* [123]
 - 4.23.3. *Development.* [62]
 - 4.23.4. *Economics.* [129], [242]
 - 4.23.5. *Energy.* [49], [62]
 - 4.23.6. *Food.* [96]
 - 4.23.7. *Forestry.* [117], [147]
 - 4.23.8. *Government.* [89]
 - 4.23.9. *Health.* [24], [66], [210], [212], [308]
 - 4.23.10. *Location.* [212]
 - 4.23.11. *Mining.* [27], [59], [89], [107]
 - 4.23.12. *Nutrition.* [140]
 - 4.23.13. *Society.* [123], [129], [171]

4.23.14. *Transport*. [107], [251]

4.23.15. *Water*. [171], [172], [215]

4.24. **Zimbabwe(24)**.

4.24.1. *Agriculture*. [61], [165], [193], [208], [230], [236], [251], [256], [267], [345]

4.24.2. *Economics*. [5], [159], [242], [267], [276]

4.24.3. *Energy*. [157], [159]

4.24.4. *Finance*. [5]

4.24.5. *Food*. [101], [193]

4.24.6. *Forestry*. [189], [229]

4.24.7. *Health*. [66], [276], [290]

4.24.8. *Land Resources*. [165]

4.24.9. *Location*. [256], [273]

4.24.10. *Transport*. [251]

4.24.11. *Veterinary work*. [256], [257]

4.24.12. *Water*. [131], [208],

5. SUBJECTS

In this section the topics are listed, without subdividing by country.

5.1. **Agriculture**. [1], [7], [10], [11], [12], [13], [14], [15], [17], [18], [20], [21], [25], [30], [33], [35], [41], [47], [48], [57], [58], [61], [69], [74], [80], [81], [84], [85], [86], [87], [88], [91], [93], [94], [95], [96], [98], [99], [100], [105], [115], [116], [119], [121], [122], [127], [128], [130], [132], [134], [137], [138], [144], [145], [146], [147], [150], [158], [160], [163], [166], [168], [169], [170], [176], [179], [180], [187], [191], [193], [195], [196], [197], [201], [202], [207], [208], [217], [218], [225], [226], [228], [230], [231], [232], [236], [245], [247], [248], [249], [251], [252], [253], [254], [256], [258], [259], [264], [265], [266], [267], [268], [274], [279], [280], [284], [286], [289], [291], [292], [294], [295], [296], [298], [299], [305], [306], [307], [310], [311], [313], [315], [316], [318], [321], [323], [325], [326], [328], [329], [332], [335], [341], [345]

5.2. **Communications**. [60], [64], [65], [327]

5.3. **Conservation**. [3], [29], [46], [120], [123], [158], [170], [187], [226], [271], [321], [334]

5.4. **Development**. [40], [41], [43], [47], [62], [63], [90], [104], [138], [203], [272]

5.5. **Economics**. [5], [20], [21], [56], [82], [90], [95], [122], [129], [159], [161], [218], [225], [238], [242], [243], [267], [272], [276]

5.6. **Education**. [47], [182], [222], [223]

5.7. **Emergencies**. [34], [76]

5.8. **Energy**. [49], [54], [55], [62], [103], [118], [126], [149], [157], [159], [162], [200], [233], [239], [240], [244], [270], [283], [320], [336]

5.9. **Environment**. [42], [46], [213], [300]

5.10. **Finance.** [5], [10], [20], [56], [125]

5.11. **Food.** [15], [96], [101], [116], [154], [193]

5.12. **Forestry.** [3], [9], [26], [94], [117], [139], [147], [166], [188], [189], [211], [220], [228], [229], [233], [246], [259], [261], [275], [280], [291], [298], [311], [312], [318], [326], [332], [333], [337]

5.13. **Government.** [40], [71], [82], [89], [135], [154], [294], [295]

5.14. **Health.** [6], [16], [22], [24], [32], [37], [51], [52], [53], [66], [67], [74], [77], [92], [108], [109], [110], [111], [112], [113], [128], [132], [133], [143], [152], [156], [167], [181], [182], [183], [184], [186], [190], [198], [199], [210], [212], [219], [221], [224], [227], [238], [250], [262], [276], [277], [278], [288], [290], [301], [304], [308], [312], [314], [319], [322], [331], [338], [340], [344]

5.15. **Industry.** [4], [63]

5.16. **Land resources.** [8], [86], [105], [165], [298], [310], [329], [341]

5.17. **Location.** [108], [212], [256], [269], [273], [339]

5.18. **Malaria.** [36], [67], [109], [190], [198], [199], [219], [303], [342]

5.19. **Mining.** [27], [59], [89], [107], [287], [323],

5.20. **Nutrition.** [21], [74], [102], [128], [137], [140], [217], [247], [296]

5.21. **Planning.** [135], [203]

5.22. **Pollution.** [283]

5.23. **Relief.** [34], [76]

5.24. **Society.** [10], [21], [105], [120], [123], [129], [166], [171], [243], [311], [330]

5.25. **Tourism.** [28], [31], [46]

5.26. **Transport.** [19], [72], [93], [107], [153], [209], [213], [214], [225], [241], [251], [269]

5.27. **Veterinary work.** [47], [91], [134], [150], [191], [256], [257]

5.28. **Waste management.** [263], [297], [339]

5.29. **Water.** [8], [30], [47], [50], [83], [97], [99], [115], [119], [126], [130], [131], [136], [141], [142], [148], [155], [161], [163], [164], [166], [171], [172], [178], [179], [180], [185], [208], [215], [235], [245], [255], [260], [264], [266], [279], [282], [293], [305], [309], [329], [343],

6. CONCLUSIONS

This paper has listed and classified over 300 published research papers that are concerned with countries in sub-Saharan Africa. The total should be an encouragement that there is evidence of people with O.R. expertise working in and for these countries. The subjects for study concentrate on the most pressing needs of these developing nations: agriculture, health and water. A smaller number of papers feature the infrastructure and progression of society. The bibliography shows that there is scope for the exchange of ideas. For example, Swaziland and Lesotho are comparatively close to Mozambique; the first two nations have five papers between them compared with 12 from Mozambique. Several topics overlap, but there is no reason why lessons from the study in Mozambique's elephant reserve [46] could not be applied to tourism and conservation in Lesotho and Swaziland.

This paper is part of an ongoing project and the author would value information about other published work relating to O.R. in Africa and the developing world.

In the author's earlier paper, he drew attention to gaps in the literature of O.R. in west Africa. The same message applies here: who will pioneer operational research in those countries of sub-Saharan Africa where there is little evidence of it having been done? What about Equatorial Guinea, Lesotho, Republic of Congo, Burundi, Djibouti and Western Sahara?

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KEY: Abal1975
- [2] Akinwumi A. Adesina. Conditioning trends shaping the agricultural and rural landscape in Africa. *Agricultural Economics*, 41:73–82, 2010. publisher: Blackwell Publishing Inc; ISSN: 1574-0862; also available as: [//dx.doi.org/10.1111/j.1574-0862.2010.00490.x](https://dx.doi.org/10.1111/j.1574-0862.2010.00490.x).
KEY: Ades2010
ANNOTATION: African countries continue to face deepening food crises that have been accentuated by the global food, energy, and financial crises. This situation is part of a long-term structural problem: decades of under-investments in agricultural sector and poor policies of support for smallholder farmers who form the bulk of the farming population. The inability of these farmers to achieve a supply response when commodity prices were high and market access was less of a problem suggests that there are multiple sets of binding constraints that continue to limit the potential of agricultural growth to reduce food security and poverty on the continent. This article reviews some of the historical trends that have hampered the performance of the agriculture sector. In addition, it reviews the impacts of more positive trends that could stimulate agricultural growth in Africa that could change the African agricultural landscape. The article however warns that there are more recent global developments and some continental challenges that could prevent or slow agricultural growth. These include the global financial crisis, public sector investments, inequities in global agricultural development policies, rush for agricultural lands by foreign investors, domestic commercial financing markets, climate change, and emerging carbon markets. The article argues that while opportunities for accelerated growth exists for African agriculture, new sets of policy instruments will be needed to support smallholder farmers to access new agricultural technologies, finance, reduce impacts of climate change, and adopt sustainable land use practices that can allow them to benefit from emerging global carbon markets.
- [3] Deepak K Agarwal, John G Mickelson Jr., Robert E Dewar, John A Silander Jr., and Alan E Gelfand. Tropical deforestation in Madagascar: analysis using hierarchical, spatially explicit, Bayesian regression models. *Ecological Modelling*, 185(1):105–131, June 2005.
KEY: AgarEtAl2005
ANNOTATION: Establishing cause-effect relationships for deforestation at various scales has proven difficult even when rates of deforestation appear well documented. There is a need for better explanatory models, which also provide insight into the process of deforestation. We propose a novel hierarchical modeling specification incorporating spatial association. The hierarchical aspect allows us to accommodate misalignment between the land-use (response) data layer and explanatory data layers. Spatial structure seems appropriate due to the inherently spatial nature of land use and data layers explaining land use. Typically, there will be missing values or holes in the response data. To

accommodate this we propose an imputation strategy. We apply our modeling approach to develop a novel deforestation model for the eastern wet forested zone of Madagascar, a global rain forest ‘hot spot’. Using five data layers created for this region, we fit a suitable spatial hierarchical model. Though fitting such models is computationally much more demanding than fitting more standard models, we show that the resulting interpretation is much richer. Also, we employ a model choice criterion to argue that our fully Bayesian model performs better than simpler ones. To the best of our knowledge, this is the first work that applies hierarchical Bayesian modeling techniques to study deforestation processes. We conclude with a discussion of our findings and an indication of the broader ecological applicability of our modeling style.

- [4] Sumer C Aggarwal. Practical applications of OR in an underdeveloped nation. *European Journal of Operational Research*, 77(3):357 – 374, 1994.

KEY: Agga1994

ANNOTATION: This paper discusses 13 specific problematic situations, which were presented to the author by the government of Somalia, an underdeveloped nation in East Africa. These situations are totally different from the ones for which decision methods have already been developed by OR specialists. Each one of these emerged under extremely poor and harsh economic and political environments. The primary objective pursued in each case was to make the situation tolerable for as many people as possible. We could group these situations into two categories – 1) micro-level, and 2) national level. Each situation is described and analyzed in a separate subsection. First, the background conditions are highlighted; next, the government objectives for the situation are brought into focus. Before starting with the analysis, all the existing constraints and limits impinging upon the situation in question are elaborated upon. This is followed by discussions about the assumptions which had to be made for developing each model or decision methodology. Further, the paper outlines the possible surprises or management dilemmas which may pop up during implementation of the decision. Next, certain precautions or remedies to deal with such surprises are suggested. Finally, a realistic assessment of the effectiveness of each of these models or decision methodologies is provided. In conclusion, the paper adds a few comments in relation to some of the possible questions or arguments likely to be raised by some OR experts. The 13 problem areas are summarised as:

- Pricing of sugar produced by a mill;
- Smoothing (sic) bottled milk shortages;
- Establishing electric power tariffs;
- Minimizing total opportunity losses for delayed deliveries; [specifically, animals for export to Gulf States]
- Estimating the availability of iron and steel scrap;
- Deciding on automated plant versus general purpose machinery; [including manpower planning]
- Setting national priorities for allocating available foreign exchange;
- Allocating limited capital to production of critical commodities; [including food production for nutrition]
- Minimizing breakdowns under continual shortages of spares;
- Prioritizing [production] plants for rehabilitation;
- Optimizing admissions to vocational/technical schools;
- Maximizing creation of jobs for school graduates;
- Deciding on foreign management agency versus national managers.

- [5] Paul Alagidede and Theodore Panagiotidis. Modelling stock returns in Africa’s emerging equity markets. *International Review of Financial Analysis*, 18(1-2):1 – 11, 2009.

KEY: AlagPana2009

ANNOTATION: We investigate the behaviour of stock returns in Africa’s largest markets namely, Egypt, Kenya, Morocco, Nigeria, South Africa, Tunisia and Zimbabwe. The validity of the random walk hypothesis is examined and rejected by employing a battery of tests. Secondly we employ smooth transition and conditional volatility models to uncover the dynamics of the first two moments and examine weak form efficiency. The empirical stylized facts of volatility clustering, leptokurtosis and leverage effect are present in the African data.

- [6] K P Alberti, J P Guthmann, F Fermon, K D Nargaye, and R F Grais. Use of Lot Quality Assurance Sampling (LQAS) to estimate vaccination coverage helps guide future vaccination efforts. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 102(3):251–254, March 2008.

KEY: AlbeEtAl2008

ANNOTATION: Inadequate evaluation of vaccine coverage after mass vaccination campaigns, such as used in national measles control programmes, can lead to inappropriate public health responses. Overestimation of vaccination coverage may leave populations at risk, whilst underestimation can lead to unnecessary catch-up campaigns. The problem is more complex in large urban areas where vaccination coverage may be heterogeneous and the programme may have to be fine-tuned at the level of geographic subunits. Lack of accurate population figures in many contexts further complicates accurate vaccination coverage estimates. During the evaluation of a mass vaccination campaign carried out in N'Djamena, the capital of Chad, Lot Quality Assurance Sampling was used to estimate vaccination coverage. Using this method, vaccination coverage could be evaluated within smaller geographic areas of the city as well as for the entire city. Despite the lack of accurate population data by neighbourhood, the results of the survey showed heterogeneity of vaccination coverage within the city. These differences would not have been identified using a more traditional method. The results can be used to target areas of low vaccination coverage during follow-up vaccination activities.

- [7] Arega D Alene, James Gockowski, and Victor M Manyong. The production efficiency of intercropping annual and perennial crops in southern Ethiopia: A comparison of distance functions and production frontiers. *Agricultural Systems*, 91(1–2):51–70, November 2006.

KEY: AlenEtAl2006

ANNOTATION: This study measures the efficiency of intercropping systems of annual and perennial crops production in southern Ethiopia using the stochastic frontier production function (SFP), parametric distance functions (PDF), and data envelopment analysis (DEA), and compares the empirical performances of the three methods. The results from the multi-output PDF and DEA approaches have revealed significantly higher efficiency of the systems than the single-output SFP approach. We find that both DEA and PDF are appropriate in multi-output agriculture involving intercropping of annual and perennial crops. Single-output measures of productivity and efficiency may thus underestimate resource use efficiency of intercropping systems. Based on the geometric mean technical efficiency predictions for each data point using the preferred PDF and DEA approaches, the sample farmers in southern Ethiopia have an average technical efficiency of 91%. The results confirm farmers' efficient use of land and other resources through innovative cropping systems. Technologies that are appropriate to such systems may thus be needed for greater intensification.

- [8] Osman Mirghani Mohamed Ali. From vision to action: Towards a national policy for integrated water management in Sudan. In Abdulrahman S Alsharhan and Warren W Wood, editors, *Water Resources Perspectives: Evaluation, Management and Policy*, volume 50 of *Developments in Water Science*, pages 237 – 244. Elsevier, 2003.

KEY: Ali2003

ANNOTATION: An overview of the water resources in Sudan and the patterns of their utilization is given. Through an evaluating perspective, the problems and constraints are outlined. Sudan's efforts in the realm of water resources conservation and rational exploitation are reviewed. From an oblique reference to an environmental policy in the 1973 Constitution to the proposed National Water Policy of 1999, the legislation, policies and plans were followed. Prior to 1992 policies and legislation were fragmented. In the National Comprehensive Strategy for Development (1992-2002) the water resources sector was considered as a subsector of the agricultural sector. Currently, the water sector in Sudan is characterized by overlapping legal regimes and the situation is further complicated by the federal system of governance. The proposed Water Policy covers a wide variety of issues. It is built upon twelve overarching policy principles and objectives set out to embrace areas of water resources, utilization, water and the environment, regional water issues, socio-economic issues, disaster management and public safety and institutions, capacity building and technical assistance. It is envisaged that the adoption and implementation of the National Water Policy would mark a milestone in the history of Sudan's development. The policy is reviewed and appraised. Specific aspects where the proposed policy needs strengthening were highlighted.

- [9] J C Allen. Multiobjective regional forest planning using the noninferior set estimation (NISE) method in Tanzania and the United States. *Forest Science*, 32(2):517–533, 1986.

KEY: Alle1986

- [10] J Alwang and P B Siegel. Labor shortages on small landholdings in Malawi: Implications for policy reforms. *World Development*, 27(8):1461–1475, 1999.

KEY: AlwaSieg1999

ANNOTATION: A simple linear programming model of representative smallholder households is used

to investigate the sources of relative scarcity of labor and land in Malawi. The paradox of on-farm labor shortages on small landholdings can be explained by the multiple constraints smallholders face. These multiple constraints, including lack of finance, concerns for food security, and others, lead to suboptimal allocations of household resources. In turn, the low returns to labor and land, contribute to household food insecurity and a vicious cycle of poverty. The findings of the paper provide a clear signal of policymakers and research and extension institutions that these constraints are all linked, and addressing one cannot be effective without addressing the others.

- [11] Glenn C W Ames and Leng-Makanda Ngemba. Poultry production for the urban market in developing countries: The case of Zaire. *Agricultural Systems*, 19(2):111 – 125, 1986.
KEY: AmesNgem1986
ANNOTATION: The profitability of establishing commercial poultry enterprises supplying the main urban markets in Zaire was evaluated in this study. In 1982 data were collected from eight layer farms, ranging in size from 80 to 150 000 layers per production period, located in Bas-Zaire and areas surrounding Kinshasa, Zaire. In addition, data were also collected from three farms that produced broilers as well as eggs. These poultry enterprises were analyzed, based upon their current level of production capacity, input costs and annual net returns. The results indicate that the profitability of layer farms appeared to be influenced by the rate of mortality, the rate of laying and the high cost of imported supplies such as hatching eggs, baby chicks, medications, vitamins, minerals and protein feeds. A low-cost poultry feed ration that met the requirements for both broilers and layers was developed using mainly Zairian ingredients. Access to lower cost medical supplies, better management practices and cheaper feeds appeared to be the key to expanding commercial poultry enterprises in Zaire and other developing countries.
- [12] Glenn C W Ames, Donald W Reid, and Li-Fang Hsiou. Risk analysis of new maize technology in Zaire: a portfolio approach. *Agricultural Economics*, 9(3):203 – 214, 1993.
KEY: AmesEtAl1993
ANNOTATION: Risk associated with the adoption of new maize technology and the impact of mandatory cotton production on traditional farmers in the Kasai Oriental Region of Zaire are evaluated within a portfolio context using a quadratic programming model. Seasonal net returns for farm plans including four levels of maize technology in combination with staple food crops are evaluated, with and without mandatory cotton production. The results indicate that cropping systems that include new maize technology are risk-efficient relative to local maize varieties while mandatory cotton production is not risk-efficient at the prevalent price and yield levels in the farming system.
- [13] Glenn C W Ames, Donald W Reid, and Tshidinda M Lukusa. New maize technology in Zaire: An application of risk analysis. *Food Policy*, 14(1):78 – 82, 1989.
KEY: AmesEtAl1989
ANNOTATION: The risk associated with new maize technology and the impact of mandatory cotton production on traditional farmers in the Kasai Oriental Region of Zaire were evaluated using stochastic dominance analysis. Net returns for four levels of maize technology for the primary and secondary rainy seasons were evaluated in combination with three staple food crops for four cropping systems with and without mandatory cotton cultivation. The results indicate that cropping systems including new maize technology are first-order stochastic dominant in both seasons, over cropping systems using local maize. Also, the increase in expected net returns for new maize technology appears to compensate farmers for its increased variability; and mandatory cotton production is not risk efficient at current price and yield levels.
- [14] Glenn C W Ames and Ossamba Ona Lofe Tonyemba. A farming systems analysis of cotton production in the Haut-Zaire region of Zaire: The impact of negative price policies. *Agricultural Systems*, 32(2):175 – 191, 1990.
KEY: AmesTony1990
ANNOTATION: The impact of government policies on cotton farming in Haut-Zaire was analyzed in a Farming Systems Perspective. The decline of cotton production in Zaire can partially be explained by the government's artificially low fixed cotton prices and a mandated minimum area quota which completely ignores resource allocation in the local farming system. Analysis of survey data from cotton-farmer households in eight zones of the Haut-Zaire region indicates that cotton production interferes with labor requirements for food crops such as maize, cassava, rice and peanuts. Returns per man-day of labor in cotton production were only 6% of the average returns to maize and cassava, the next alternatives, creating severe disincentives among peasant farmers to continue cotton production.
- [15] A S Anderson. The effect of cash cropping, credit, and household composition on food security in southern Malawi. *African Urban Quarterly*, 6(1-2):161–186, 2002.

KEY: Ande2002

ANNOTATION: Diversifying household activities is essential to household food security in Southern Malawi. Farms are extremely small; many farms are less than half a hectare. With these small landholdings, food security cannot be achieved by subsistence farming alone. Cash crops and off-farm income are key to these livelihood systems. This paper presents the findings of research conducted in 1998 as a part of a study to examine options for improving household food security in Southern Malawi. The researcher used linear programming to model household farming systems. These models were used to test different options for improving food security. The following options were tested: a maize safety net, a fertilizer safety net, introducing credit for tobacco, increasing off-farm work opportunities, and introducing a loan to start a small business. This study also considered differences between female-headed households (FHHs) and male-headed households (MHHs) to discover if there were differences between the two household types, and if so, to find out how the differences affect the households' situations.

- [16] N Andersson and S Marks. The state, class and the allocation of health resources in southern Africa. *Social Science and Medicine*, 28(5):515–530, 1989.

KEY: AndeMark1989

ANNOTATION: In Africa the literature specifically linking the state, class and the allocation of health resources is sparse, and the evidential base for health research is inadequate and difficult to interpret. This paper looks at some of the ways in which state, class and health may be related in southern Africa. The region provides useful comparisons because of the starkness of the relationships between class and race and disease patterns and health care in much of the sub-continent; the different types of state and class structure within southern Africa; and the changes in ideology and to some extent health practice which came with the political independence of some of its component parts. Using both historical and contemporary data, it pinpoints the importance of analyzing the specific and changing form of the state in the different countries of the region, in order to understand the social determinants of disease and the allocation of health resources, and looks at the significance of class, race, ethnicity and gender in the incidence of health and the state's response. It highlights the specific colonial legacies, continuing imperial linkages and location of countries in the international division of labour which inhibit changes in health care. Within the region, the migrant labour system and South Africa's aggressive policies of destabilisation create particular problems for weak states and for individuals within them attempting to implement more progressive health care programmes. The paper also argues that the ideological role played by health care has to be understood, and shows the diverse uses to which it is put across the region. The paper concludes that while the und position of the state in the international and regional economy, its specific form and the nature of its class relations are predictors in some sense of health and health care, a variety of micro-level political and social decisions and mediations have also to be taken into account. While most of the countries of the region are in some sense part of the 'periphery', and a product of colonialism, these labels are insufficient to explain the differences between them in terms of disease patterns and health care systems. The specificities of internal social dynamics, local class ethnic and gender struggles and political conflicts are also crucial.

- [17] Anonymous. Attaining global food security by 2025. Technical Report 3, International Policy Council on Agriculture, Food and Trade, Washington, D.C., USA, November 1996.

KEY: Anon1996

- [18] J Antoine, G Fischer, and M Makowski. Multiple criteria land use analysis. *Applied Mathematics and Computation*, 83(2-3):195–215, May 1997.

KEY: AntoEtAl1997

ANNOTATION: Since the early 1980s, the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA) have been collaborating on expanding FAO's Agro-Ecological Zones (AEZ) methodology of land resources appraisal by incorporating decision support tools for optimizing the use of land resources. Initially, these tools consisted of the application of linear optimization techniques for analyzing land-use scenarios with regard to single objective functions, such as maximizing agricultural production or minimizing the cost of production under specific physical environmental and socio-economic conditions and constraints. Often, the specification of a single objective function does not adequately reflect the preferences of decision-makers, which are of a multiobjective nature in many practical problems dealing with resources. Multicriteria optimization approaches address problem definitions and solutions in a more realistic way and have recently been applied by FAO and IIASA in a

land resources appraisal study in Kenya. In this study, optimization techniques coupled with multicriteria decision analysis (MCDA) techniques, using the Aspiration-Reservation Based Decision Support (ARBDS) approach, have been used to analyze various land use scenarios, considering simultaneously several objectives such as maximizing revenues from crop and livestock production, maximizing district self-reliance in agricultural production, minimizing costs of production and environmental damages from erosion. The main users of the new tool being developed, which combines AEZ and MCDA, are expected to be natural resources analysts and managers, land-use planners, ecologists, environmentalists, economists at national and regional levels, and agricultural extensionists at the local scale.

- [19] Jean-Francois Arvis, Gael Raballand, and Jean-Francois Marteau. *The cost of being landlocked: logistics costs and supply chain reliability*. Number 4258 in Policy Research Working Papers. World Bank, Washington, D.C., 1st edition, 2007.

KEY: ArviEtAl2007

ANNOTATION: A large proportion of the least developed countries are landlocked and their access to world markets depends on the availability of a trade corridor and transit systems. Based on empirical evidence from World Bank projects and assessments in Africa, Central Asia, and elsewhere, this paper proposes a microeconomic quantitative description of logistics costs. The paper theoretically and empirically highlights that landlocked economies are primarily affected not only by a high cost of freight services but also by the high degree of unpredictability in transportation time. The main sources of costs are not only physical constraints but widespread rent activities and severe flaws in the implementation of the transit systems, which prevent the emergence of reliable logistics services. The business and donor community should push toward implementation of comprehensive facilitation strategies, primarily at the national level, and the design of robust and resilient transport and transit regimes. A better understanding of the political economy of transit and a review of the implementation successes and failures in this area are needed.

- [20] T Assefa and R C Agrawal. An integrated approach to appraisal of agricultural projects for financing: combination of optimization and investment techniques. *Quarterly Journal of International Agriculture*, 29(1):5–26, 1990.

KEY: AsseAgra1990

ANNOTATION: Agricultural planners and financial institutions make use of the conventional financial and economic analysis to evaluate agricultural development projects in developing countries to determine priorities for allocating limited funds to these projects. In this paper, the authors have suggested an integrated approach to project appraisal. It combines the use of optimization techniques and the usual investment analysis. The application of this approach has been demonstrated for appraising projects by a development bank to finance cooperative farms pursuing mixed farming in Central Highlands of Ethiopia. First optimum integration of crops and livestock on synthetic producer cooperative farm models is determined by using linear programming. Then, the financial viability of these cooperatives is assessed on the basis of this optimum plan. Finally, optimal investment requirements and credit needs to be met by the financial institutions for the same are estimated.

- [21] A Athanasios, M Bezuneh, and B J Deaton. Impacts of FFW (Food For Work) on nutrition in rural Kenya. *Agricultural Economics*, 11(2–3):301–309, 1994.

KEY: AthaEtAl1994

ANNOTATION: Primary data collected from a random sample of 300 farm-households in the Rift Valley Province of Kenya and a linear programming model are used to estimate own and cross-piece elasticities for each nutrient component. The results indicate that FFW significantly improves the nutritional status of FFW participant households. More specifically, participants experienced an implicit income gain, which resulted in a significant nutritional improvement. The poorest FFW participant households exhibited even higher nutritional gains (32.46%) than those participants from relatively higher income groups. FFW participant households showed a 90% higher propensity to spend on nutrients than the non-FFW participants.

- [22] Bertran Auvert, Ph. Aegerter, F Van Look, Le Thi Huong Du, Ph. Boutin, J L Monier, X Emmanuelli, V Gilbos, and E Benillouche. A hand-held decision-aid system designed for rural health workers. *Computers and Biomedical Research*, 19(1):80 – 89, 1986.

KEY: AuveEtAl1986

ANNOTATION: A great part of the world's population is cared for by rural health workers who are also collecting data for epidemiological studies. These workers have a low level of medical training and are working in a poor technical environment. At the request of an international humanitarian and medical organization (Médecins Sans Frontières), we have developed an integrated (hardware

and software) system, TROPICAID, based on a hand-held computer and designed to increase rural health workers' efficiency. The software is easy to use and enables users to get information from an internal data base on 60 drugs. The decision-making module analyzes the patient's parameters (460 different symptoms are recognized) and indicates possible diagnoses (the system knows 210) and relevant treatments. In addition, the system facilitates the collection of medical data for elementary statistical analysis. The computer, which is lightweight (1.5 kg) and compact, runs on battery power for up to a week in normal use. The program which is written in Pascal and data are stored in high-capacity EPROMs. An early trial in Chad with Médecins Sans Frontières has shown the value of such a project as well as a few weaknesses to be overcome.

- [23] Y. Azoumah, D. Yamegueu, P. Ginies, Y. Coulibaly, and P. Girard. Sustainable electricity generation for rural and peri-urban populations of sub-saharan africa: The *flexy-energy* concept. *Energy Policy*, 39(1):131–141, 2011.

KEY: AzouEtAl2011

ANNOTATION: Access to energy is known as a key issue for poverty reduction. Electrification rate of sub-Saharan countries is one of the lowest among the developing countries. However, this part of the world has natural energy resources that could help raising its access to energy, then its economic development. An original *flexy-energy* concept of hybrid solar PV/diesel/biofuel power plant, without battery storage, is performed in this paper. This concept is developed in order to not only make access to energy possible for rural and peri-urban populations in Africa (by reducing the electricity generation cost) but also to make the electricity production sustainable in these areas. For landlocked countries like Burkina Faso, this concept could help them reducing their electricity bill (then their fuel consumption) and accelerate their rural and peri-urban electrification coverage.

- [24] Max O Bachmann. Cost effectiveness of community-based therapeutic care for children with severe acute malnutrition in Zambia: decision tree model. *Cost Effectiveness and Resource Allocation*, 7(2):9 pages, accessed 26:October:2010, January 2009.

KEY: Bach2009

ANNOTATION: Children aged under five years with severe acute malnutrition (SAM) in Africa and Asia have high mortality rates without effective treatment. Primary care-based treatment of SAM can have good outcomes but its cost effectiveness is largely unknown. This study estimated the cost effectiveness of community-based therapeutic care (CTC) for children with severe acute malnutrition in government primary health care centres in Lusaka, Zambia, compared to no care. A decision tree model compared the costs (in year 2008 international dollars) and outcomes of CTC to a hypothetical 'do-nothing' alternative. The primary outcomes were mortality within one year, and disability adjusted life years (DALYs) after surviving one year. Outcomes and health service costs of CTC were obtained from the CTC programme, local health services and World Health Organization (WHO) estimates of unit costs. Outcomes of doing nothing were estimated from published African cohort studies. Probabilistic and deterministic sensitivity analyses were done. The mean cost of CTC per child was USD203 (95% confidence interval (CI) USD139-USD274), of which ready to use therapeutic food (RUTF) cost 36%, health centre visits cost 13%, hospital admissions cost 17% and technical support while establishing the programme cost 34%. Expected death rates within one year of presentation were 9.2% with CTC and 20.8% with no treatment (risk difference 11.5% (95% CI 0.4-23.0%). CTC cost USD1760 (95% CI USD592-USD10142) per life saved and USD53 (95% CI USD18-USD306) per DALY gained. CTC was at least 80% likely to be cost effective if society was willing to pay at least USD88 per DALY gained. Analyses were most sensitive to assumptions about mortality rates with no treatment, weeks of CTC per child and costs of purchasing RUTF. CTC is relatively cost effective compared to other priority health care interventions in developing countries, for a wide range of assumptions.

- [25] Frederick P Bajjukya. *Adapting to change in banana-based farming systems of northwest Tanzania: the potential role of herbaceous legumes*. PhD thesis, Wageningen University, Wageningen, Netherlands, November 2004.

KEY: Bajj2004

ANNOTATION: The banana-based farming system in Bukoba District, Tanzania, has been in existence for over 300 years. At present, banana productivity in home gardens is declining largely due to the decline in soil fertility, which in many years was counteracted by the availability of manure. The grazing land is being converted to crop fields and other uses. Crop fields have in part, assumed the role of grazing land of providing for fodder to the few cattle kept today, which is not sustainable in many years. This thesis firstly, describes the changes in the system that occurred. Secondly it explores opportunities for integrating herbaceous legumes in the farming system, to act as an engine to maintain the farming system by providing fodder to the cattle (hence manure for use in the home gardens) and ameliorating the fertility of soils of annual crop fields as improved

fallows. The area of grasslands was shown to have decreased over 50 years by 40% whereas the area of annual crop fields increased by 225%. Encroachment on grassland reduced the ability of farmers to restore the fertility of their soils as possibilities to keep livestock, thus the supply of manure diminished. This had a consequence on nutrient balances where by the home gardens receiving manure, had positive balances of N, P and K whereas the home gardens receiving no manure had negative nutrient balances. Nutrient balances of annual crops were negative particularly with maize, indicating that they are vulnerable to impoverishment. Field experiments showed that the biomass, N accumulation and N₂-fixation varied among the legume species. The performance of legumes was regulated by the soil N and the soil pH. The non-forage species *Tephrosia candida*, *Crotalaria grahamiana* and the forage species *Mucuna pruriens* and *Macrotyloma axillare* performed better among the tested legumes, and were selected by farmers on the basis of biomass yield, weed suppression and tolerance to pest and diseases. Laboratory experiments showed that the rate of N release from decomposing legume residues depended on the quality [(polyphenols + lignin)-to-N ratio, lignin-to-N ratio and lignin content] of residues, whereby residues with low (polyphenols + lignin)-to-N ratio, lignin-to-N ratio or lignin contents decomposed faster.

- [26] Bedru Babulo Balana, Erik Mathijs, and Bart Muys. Assessing the sustainability of forest management: An application of multi-criteria decision analysis to community forests in northern Ethiopia. *Journal of Environmental Management*, 91(6):1294 – 1304, 2010.

KEY: BalaEtAl2010

ANNOTATION: Continuous deterioration of the natural resource base has become a serious threat to both the ecological systems and economic production in Ethiopia. Many of these problems have been attributed directly or indirectly to the rapid dwindling of the country's forest cover which is associated with unsustainable forest use and management. Closing community woodlands from human and livestock intervention to promote natural regeneration of forests has been one of the environmental restoration strategies pursued in the degraded highland areas of northern Ethiopia. However, local pressure to use reforested community lands for economic benefit has become a major threat to forest sustainability. Using locally identified sets of criteria and indicators for sustainable community forest management, this paper applies a multi-criteria decision analysis tool to evaluate forest management problems in the northern province of Tigray, Ethiopia. Three MCA methods - ranking, pair-wise comparison, and scoring - were used in evaluating the sets of criteria and indicators and alternative forest management scenarios. Results from the study indicate a number of noteworthy points: 1) MCA techniques both for identifying local level sustainability criteria and indicators and evaluating management schemes in a participatory decision environment appear to be effective tools to address local resource management problems; 2) Evaluated against the selected sets of criteria and indicators, the current forest management regime in the study area is not on a sustainable path; 3) Acquainting local people with adequate environmental knowledge and raising local awareness about the long-term consequences of environmental degradation ranked first among the set of sustainability criteria; and 4) In order to harmonize both environmental and economic objectives, the present 'ecological-biased' forest management regime needs to be substituted by an appropriate holistic scheme that takes into account stakeholders' multiple preferences and priority rankings.

- [27] B Barlin, M J Abraham, and T W O'Connor. Evaluation of the introduction of Waelz kilns at Broken Hill Division of Nchanga Consolidated Copper Mines, Ltd., Zambia. *Transactions of the Institution of Mining and Metallurgy, Section C: Mineral Processing and Extractive Metallurgy*, 82(805):214–220, 1973.

KEY: BarlEtAl1973

ANNOTATION: The Broken Hill Division of Nchanga Consolidated Copper Mines, Ltd, has been producing lead and zinc metals since 1904. Because of the complexity of the ore and the diversity of metallurgical processes employed there now exist large tonnages of surface dumps containing a significant proportion of metal. The evaluation of Waelz kilns as the most suitable plant to treat the surface dumps to recover the contained metal is described. The kilns will be integrated into the existing plant configuration of an imperial smelting furnace and electrolytic zinc plant. The metallurgy of the existing plant and the extended plant with kilns is described. Both these plants were mathematically modelled by use of linear programming and the 'best' plans from these programs were used for financial analysis by use of modified discounted cash flow techniques.

- [28] G L Barlow. Just-in-Time: Implementation within the hotel industry: A case study. *International Journal of Production Economics*, 80:155–167, 2002.

KEY: Barl2002

ANNOTATION: This paper sets out to report on the potential value of Just-in-Time purchasing

and inventory management within the hotel industry. Specifically, it outlines research carried out between 1998 and 1999 within two hotel groups, covering three London hotels. The first an international hotel organisation and the second, a family owned hotel company operating in England and Kenya. It examines their current inventory and purchasing policies, how they manage and maintain their inventory levels and what these policies mean, as far as the hotel operations are concerned.

- [29] J I Barnes. Economic returns and allocation of resources in the wildlife sector of Botswana. *South African Journal of Wildlife Research*, 31(3–4):141–153, 2001.

KEY: Barn2001

ANNOTATION: Wildlife utilization in Botswana was studied to find out (1) whether it generates positive contributions to national income, and (2) which combinations of uses can generate most income. Financial and economic models of different land uses were combined in linear programming and cost-benefit analyses. Results show that the wildlife resource in Botswana can contribute positively to national income, and this justifies government investment in the sector. The sector is economically efficient, and contributes to Botswana's economic development. Wildlife uses need to be fully developed in ways that maximize their economic contributions. Non-consumptive tourism on high-quality wildlife land will give the greatest economic returns, and should get priority. Safari hunting, community-based wildlife use (where viable), and limited intensive ostrich and crocodile production should also be given priority for investment. Other uses should get lower priority, but all should be developed. On about a third of wildlife land, wildlife uses have a clear economic advantage over livestock uses. The remaining two thirds of wildlife land has poor capacity to generate use value. Here, commercial livestock ranching is not an economic threat, but traditional livestock keeping is. A ban on consumptive wildlife uses in Botswana would significantly exacerbate this threat.

- [30] T Barnett. Small scale irrigation in sub-Saharan Africa: Sparse lessons, big problems, any solutions? *Public Administration and Development*, 4(1):21–47, 1984.

KEY: Barn1984

ANNOTATION: This paper identifies from studies made of specific schemes the major social and administrative problems confronting the improvement and extension of small-scale irrigation in Africa. The first section reviews the studies and notes the conclusions to be drawn from each separate one. Underlying these separate conclusions six general problems are identified and in the second section of the article each of these six is elaborated and discussed: the relation between the direct producer's benefit and wider social benefits: problems of control, commitment to hierarchy, the working of production units, and how to learn from farmers in respect of water use; and finally the general problem of how to plan for the further change that follows after irrigation is introduced.

- [31] Carlos Pestana Barros and Peter U C Dieke. Technical efficiency of African hotels. *International Journal of Hospitality Management*, 27(3):438 – 447, 2008.

KEY: BarrDiek2008

ANNOTATION: This paper uses data envelopment analysis (DEA) to estimate the technical efficiency of 12 hotels in Luanda, Angola. The study uses a balanced data set with 84 observations over the years 2000-2006. In a second stage, this paper uses a bootstrapping method (rather than a Tobit regression) developed by Simar and Wilson (2007) to estimate the economic drivers behind the technical efficiency. They find that efficiency has risen over the studied period, but at a decreasing rate. Secondly, they find that a hotel's membership in a group increases efficiency. Greater market share as measured by a Herfindahl index, increases efficiency and finally, hotels with an international strategy have higher efficiencies.

- [32] C T Bauch, E Szusz, and L P Garrison. Scheduling of measles vaccination in low-income countries: Projections of a dynamic model. *Vaccine*, 27(31):4090–4098, June 2009.

KEY: BaucEtAl2009

ANNOTATION: Large-scale vaccination campaigns (SIAs) and improved routine immunization (RI) have greatly reduced measles incidence in low-income countries. However, the interval between SIAs required to maintain these gains over the long term is not clear. We developed a dynamic model of measles transmission to assess measles vaccination strategies in Cambodia, Ghana, India, Morocco, Nigeria, and Uganda. We projected measles cases from 2008 to 2050 under (a) holding SIAs every 2,4,6, or 8 years, (b) improvements in first dose routine measles vaccine (MCV1) coverage of 0%, 1%, 3% annually, and (c) introducing MCV2 once MCV1 coverage reaches 70%, 80%, 90%. If MCV1 continues improving, then India and Nigeria could hold SIAs every 4 years without significant probability of large outbreaks, and the other countries every 6-8 years. If RI

remains stagnant, India and Nigeria should hold SIAs every 2 years, and the other countries every 4-6 years.

- [33] M S Bazaraa and A Bouzaher. A linear goal programming-model for developing-economies with an illustration from the agricultural sector in Egypt. *Management Science*, 27(4):396–413, 1981.

KEY: BazaBouz1981

- [34] Benita M Beamon and Stephen A Kotleba. Inventory management support systems for emergency humanitarian relief operations in south Sudan. *The International Journal of Logistics Management*, 17(2):187–212, May 2006.

KEY: BeamKotl2006

ANNOTATION: Purpose To develop and test three different inventory management strategies as applied to the complex emergency in south Sudan. Design/methodology/approach Quantitative modeling, simulation, and statistics. Findings This research identified critical system factors that contributed most significantly to inventory system performance, and identified strengths and weaknesses of each inventory management strategy. Research limitations/implications This research represents a first step in developing inventory management systems for humanitarian relief. Future work would include modeling correlation among relief items, multiple items, and considering the impact of information. Practical implications In a domain that has seen limited application of quantitative models, this work demonstrates the performance benefits of using quantitative methods to manage inventory in a relief setting. Originality/value This research has value for relief organizations by providing a real-world application of quantitative inventory management strategies applied to a complex emergency, and demonstrated performance advantages of quantitative versus ad hoc methods. This research has value for researchers by providing a new application of simulation and mathematical modeling (humanitarian relief).

- [35] H Becker. Labour input decisions of subsistence farm households in southern Malawi. *Journal of Agricultural Economics*, 41(2):162–171, 1990.

KEY: Beck1990

ANNOTATION: Presents a farm-household model which allows an analysis of labour input decisions of rural households in an environment with risky agricultural technologies and off-farm employment opportunities. Labour input decisions are condensed into a stochastic linear programming framework, and applied to a typical rural household in southern Malawi. Weak adoption of yield-increasing technologies is explained by different opportunity costs of time of family members and by the risky nature of income generated using traditional or yield-increasing agricultural technologies. The view that land-saving innovations will increase agricultural production is revised. Special extension programmes for family members with low off-farm employment opportunities are proposed to increase the adoption of those technologies.

- [36] Sylvia I Becker-Dreps, Ndeia K Biddle, Audrey Pettifor, Gertrude Musuamba, David Nku Imbie, Steven Meshnick, and Frieda Behets. Cost-effectiveness of adding bed net distribution for malaria prevention to antenatal services in Kinshasa, Democratic Republic of the Congo. *American Journal of Tropical Medical Hygiene*, 81(3):496–502, September 2009.

KEY: BeckEtAl2009

ANNOTATION: We evaluated the cost-effectiveness of distributing insecticide-treated bed nets (ITNs) for malaria prevention at antenatal clinics in Kinshasa, Democratic Republic of the Congo. A decision tree model was used to estimate costs, outcomes, and incremental cost-effectiveness for 17,893 pregnant women attending 28 antenatal clinics who received long-lasting ITNs free of charge. Costs including purchase, transportation, storage, and distribution of ITNs were derived from program records. The ITN efficacy and other parameters were derived from peer-reviewed literature. Outcomes modeled included low birth weight (LBW) deliveries, infant deaths averted, life-years saved (LYs), and disability-adjusted life-years (DALYs) averted. Deterministic and probabilistic sensitivity analyses were conducted. For the 17,893 women in our program, ITN distribution would be expected to avert 587 LBW deliveries and 414 infant deaths. The incremental cost-effectiveness was US \$17.22 per DALY averted (95% confidence interval [CI] = US \$8.54-\$30.90), US \$15.70 per LY saved (95% CI = US \$7.65-\$27.68), and US \$411.13 per infant death averted (95% CI = US \$353.95-\$1,085.89). If resources were constrained, the greatest benefit would be among women in their first through fourth pregnancies. Thus, ITN distribution is a cost-effective addition to antenatal services.

- [37] Ruth Bell, Taathi Ithindi, and Anne Low. Improving equity in the provision of primary health care: lessons from decentralized planning and management in Namibia. *Bulletin of the World Health Organisation*, 80(8):675–681, August 2002.

KEY: BellEtAl2002

ANNOTATION: This paper draws lessons from a review of primary health care services in Windhoek, the capital of Namibia, undertaken by a regional health management team. The review was carried out because of perceived increases in workload and inadequate staffing levels, arising from the rapid expansion of the city associated with inward migration. A survey of the utilization of government clinics was used to develop a more equitable allocation of primary health care services between localities. The survey revealed disparities between patterns of utilization of the services and the allocation of staff: the poorer localities were relatively underprovided. Decisions made centrally on resource allocation had reinforced the inequities. On the basis of the results of the review, the regional health management team redistributed nursing and medical staff and argued for a shift in the allocation of capital expenditure towards the poorer communities. The review demonstrates the potential for regional and provincial health management teams to make effective assessments of the needs of their populations and to promote the equitable delivery of primary health care services. In order to achieve this they need not only to become effective managers, but also to develop population-based planning skills and the confidence and authority to influence the allocation of resources between and within their regions and provinces.

- [38] Marc F. Bellemare. Agricultural extension and imperfect supervision in contract farming: evidence from Madagascar. *Agricultural Economics*, 41(6):507–517, 2010. publisher: Blackwell Publishing Inc; ISSN: 1574-0862; also available as: [//dx.doi.org/10.1111/j.1574-0862.2010.00462.x](https://dx.doi.org/10.1111/j.1574-0862.2010.00462.x).

KEY: Bell2010

ANNOTATION: Abstract This article tests whether agricultural extension and imperfect supervision-conflated here into the number of visits by a technical assistant increase productivity in a sample of contract farming arrangements between a processing firm and small agricultural producers in Madagascar. Production functions are estimated which treat the number of visits by a technical assistant as an input and which exploit the variation in the number of visits between the contracted crops grown on a given plot by a specific grower, thereby accounting for district-, grower-, and plot-level unobserved heterogeneity. Results indicate that the elasticity of yield with respect to the number of visits lies between 1.3 and 1.7.

- [39] Hakim Ben Hammouda and Patrick N. Osakwe. Global trade models and economic policy analyses: Relevance, risks and repercussions for Africa. *Development Policy Review*, 26(2):151–170, 2008. publisher: Blackwell Publishing Ltd; ISSN: 1467-7679; also available as: [//dx.doi.org/10.1111/j.1467-7679.2008.00403.x](https://dx.doi.org/10.1111/j.1467-7679.2008.00403.x).

KEY: HammEtAl2008

ANNOTATION: Computable general equilibrium models are widely used for trade policy analyses and recommendations. There is, however, increasing discomfort with the use of these models, especially in Africa. This article demonstrates that the results of several such studies of the impact of trade reforms in Africa differ drastically in terms of both magnitude and direction, failing to take account of key features of African economies. It also outlines potential consequences of the misuse of CGE models for policy evaluation and suggests pitfalls to be avoided.

- [40] Thomas Berger, Pepijn Schreinemachers, and Johannes Woelcke. Multi-agent simulation for the targeting of development policies in less-favored areas. *Agricultural Systems*, 88(1):28–43, April 2006.

KEY: BergEtAl2006

ANNOTATION: Complex combinations of biophysical and socio-economic constraints characterize the less-favored rural areas in developing countries. More so, these constraints are diverse as they vary considerably between households even in the same community. We propose multi-agent systems as a modeling approach well suited for capturing the complexity of constraints as well as the diversity in which they appear at the farm household level. Given that empirical multi-agent models based on mathematical programming share the characteristics of bio-economic farm models plus some additional features, one may interpret bio-economic farm models as a special case of multi-agent models without spatial dimension and direct interaction. Evidently, spatially explicit, connected multi-agent models have higher requirements in terms of development costs, empirical data and validation. Therefore, we see them as a complement, and not a substitute, to existing bio-economic modeling approaches. They might be the preferred model choice when heterogeneity and interactions of agents and environments are significant and, therefore, policy responses cannot be aggregated linearly. We illustrate the strength of empirical multi-agent models with simulation results from Uganda and Chile and indicate how they may assist policymakers in prioritizing and targeting alternative policy interventions especially in less-favored areas.

- [41] Mesfin Bezuneh, Brady J Deaton, and George W Norton. Food aid impacts in rural Kenya. *American Journal of Agricultural Economics*, 70(1):181–191, February 1988.

KEY: BezuEtAl1988

ANNOTATION: Assessing the potential role of food aid in economic development requires that analytical attention be given to both household production and consumption consequences of food aid projects. Effects of a food-for-work (FFW) project in rural Kenya are assessed using a peasant-household-firm model which incorporates a linear programming model and an almost ideal demand system. The results indicate that program participants have net returns 52 percent higher than nonparticipants, most of which is due to induced effects of capital formation on own-farm production. Greater capital formation increases the opportunity cost of participants' time, encouraging a transition over time from FFW activities to greater own-farm production. FFW increases food demand, employment, and marketable surplus.

- [42] A Blom. An estimate of the costs of an effective system of protected areas in the Niger Delta - Congo Basin Forest Region. *Biodiversity and Conservation*, 13(14):2661–2678, December 2004.

KEY: Blom2004

ANNOTATION: This paper presents an analysis of the costs of implementing a biodiversity conservation vision for the Niger Delta-Congo Basin Forest Region, a region covering the forests from Nigeria across Cameroon, Equatorial Guinea (EG), Gabon, Central African Republic (CAR), Congo and the Democratic Republic of Congo (DRC), based on an effectively managed and representative protected area network. The Niger Delta Congo Basin Forest Region has an existing protected area system of about 135,000 km². A system of effectively managed protected areas that would maintain a substantial part of the biodiversity would require an additional 76,000 km² to be gazetted and an investment for the total system of over \$1 billion (10⁹). After this initial 10-year investment an estimated \$87million a year would be sufficient to maintain this system. Overall, current donor expenditure in the present network is probably less than \$15 million per year, so over \$800 million dollars will have to be found elsewhere. If the international community values the biodiversity of the Niger Delta-Congo Basin Forest Region, it is going to have to cover the cost of maintaining this biodiversity.

- [43] D Bm'niyat Bangamboulou-te niya. Integration des variables demographiques dans la planification du developpement: cas de la Centrafrique. [Integration of demographic variables in development planning: the case of Central African Republic]. *Annales de l'IFORD (Institut de Formation et de Recherche Démographiques)*, 13(1):49–79, June 1989.

KEY: Bmni1989

ANNOTATION: (English translation) Development is a complex phenomenon that concerns all the structures and subsystems of a society, affecting its quantitative aspects through economic growth and its qualitative aspects through social and cultural change. Planning is needed, but it is effective only to the extent that it is applied to a known and controllable reality. The integration of population and development is still a poorly defined concept despite the fact that it has been a topic of interest for the past several decades. at least since the 1946 creation of the UN Population Commission. Development planning should begin with evaluation of the past and present economic, social, and demographic situation of the country and should include formulation of clear objectives. The Central African Republic is a huge country with some significant resources but a fragile and underdeveloped economy. The population, estimated at nearly three million, is very unevenly distributed, with half a million living in the capital of Bangui. Fertility and mortality are high. The Central African Republic has had multi year development plans since 1948, but they have largely consisted of collections of projects funded by external investment. In the absence of institutional mechanisms capable of defining priorities and strategies leading to concrete decisions, the plans remained excessively general and ambitious. Economic planning has improved somewhat over the years, but there is still a lack of basic economic and social data, a shortage of financial resources, and inadequate mechanisms for setting priorities and strategies for decision making. No mechanism has been developed for integrating population and development although some research and family planning activities have been undertaken. A 1980 national seminar on problems of development was attended by representatives of all sectors, and in 1981 a national team formulated guidelines for a new strategy of social development. Family planning services were added to the maternal-child health project created in 1978, and the 2nd national population census is underway. These positive actions have not been integrated into a framework for population and development planning. 4 phases are viewed as necessary if integration of population and development planning is to be achieved in the Central African Republic. These phases are provision of population education to all sectors; research on population variables and links between population and development especially in employment, education, and population distribution; training and

integration of skills between political authorities, planners, and researchers; and development of data bases and modelling capabilities.

- [44] Dorothe Boccanfuso and Luc Savard. The food crisis and its impacts on poverty in senegal and mali: Crossed destinies. *Development Policy Review*, 29(2):211–247, 2011.

KEY: BoccSava2011

- [45] Philippe Bocquier, Christophe J. Nordman, and Aude Vescovo. Employment vulnerability and earnings in urban West Africa. *World Development*, 38(9):1297–1314, 2010.

KEY: BocqEtAl2010

ANNOTATION: Summary This article develops indicators of vulnerability in employment in seven economic capitals of West Africa and studies their links with individual incomes. Quantitative, distributional and qualitative analyses show that vulnerability compensating mechanism is mainly seen in the informal sector, in the upper tail of the earnings distribution and particularly in the circumstance of visible underemployment. Employment vulnerability is not compensated for the poorest workers in the private sector. *Long job queues* and weak institutional protection of workers may have reduced bargaining power in the formal sector.

- [46] W F de Boer, J D Stigter, and C P Ntumi. Optimising investments from elephant tourist revenues in the Maputo Elephant Reserve, Mozambique. *Journal for Nature Conservation*, 15(4):225 – 236, 2007.

KEY: BoerEtAl2007

ANNOTATION: Private enterprises are active in conservation initiatives in Africa. Some of these enterprises have long-term licences for the development of conservation areas. The motivation of these organisations to participate in conservation is ultimately determined by the economic output of their activities. An electric fence is being constructed in the Maputo Elephant Reserve, Mozambique. A costs-benefit analysis was carried out, in order to assist in the optimisation of the management activities of the elephant population, based on elephant population size, fence costs, crop raid costs, elephant poaching, and benefits derived from tourism (game-viewing and hunting). Tourist numbers increased with increasing elephant density through a concave utility function. Optimal harvest/hunting strategies were calculated from optimal control theory, using dynamic optimisation (Pontryagin’s Maximum Principle). Poaching and raid costs could be compared to fence construction costs at different elephant population sizes. Costs generated through elephant poaching and elephant crop raid costs were higher than fence construction costs at a population size > 100 . Elephant hunting was a less favourable activity, economically and ecologically, than elephant viewing, due to the large game-viewing profits per elephant. Only if the licence fee increases from US\$6500 to 28,500 would hunting become attractive, although ecological and economical constraints would probably prevent the development of hunting activities in the area. The assumed resource price of elephant (US\$5000) was lower than the marginal value derived from tourism, indicating that elephants should be bought until the maximum stocking rate is reached.

- [47] T E S Bontkes. Dynamics of rural development in southern Sudan. *System Dynamics Review*, 9:1–21, 1993.

KEY: Bont1993

ANNOTATION: This article presents the results of a dynamic simulation study of a rural area in southern Sudan. In order to improve the living conditions of the rural population in this area, three intervention packages were planned; improved veterinary care; improved agricultural practices; and better general facilities like medical care, clean drinking water, schools, and roads. Although these interventions initially seem to benefit the rural population, some worsen the situation after a number of years when compared to the case without interventions, and others are not able to bring about a sustainable development of the area. It is concluded that analyzing the dynamics of the system can foster planning of appropriate interventions.

- [48] H W G Booltink, B J van Alphen, W D Batchelor, J O Paz, J J Stoorvogel, and R Vargas. Tools for optimizing management of spatially-variable fields. *Agricultural Systems*, 70(2-3):445 – 476, November–December 2001.

KEY: BoolEtAl2001

ANNOTATION: Efficient use of agro-chemicals is beneficial for farmers as well as for the environment. Spatial and temporal optimization of farm management will increase productivity or reduce the amount of agro-chemicals. This type of management is referred to as Precision Agriculture. Traditional management implicitly considers any field to be a homogeneous unit for management: fertilization, tillage and crop protection measures, for example, are not varied within a single field. The question for management is what to do when. Because of the variability within the field, this implies inefficient use of resources. Precision agriculture defines different management practices to be applied within single, variable fields, potentially reducing costs and limiting adverse environmental side effects. The question is not only what and when but also where. Many tools for

management and analysis of spatial variable fields have been developed. In this paper, tools for managing spatial variability are demonstrated in combination with tools to optimize management in environmental and economic terms. The tools are illustrated on five case studies ranging from (1) a low technology approach using participatory mapping to derive fertilizer recommendations for resource-poor farmers in Embu, Kenya, (2) an example of backward modelling to analyze fertilizer applications and restrict nitrogen losses to the groundwater in the Wieringermeer in The Netherlands, (3) a low-tech approach of precision agriculture, developed for a banana plantation in Costa Rica to achieve higher input use efficiency and insight in spatial and temporal variation, (4) a high-tech, forward modelling approach to derive fertilizer recommendations for management units in Zuidland in The Netherlands, and (5) a high-tech, backward modelling approach to detect the relative effects of several stress factors on soybean yield.

- [49] B H Bowen, F T Sparrow, and Z Yu. Modeling electricity trade policy for the twelve nations of the Southern African Power Pool (SAPP). *Utilities Policy*, 8(3):183–197, 1999.

KEY: BoweEtAl1999

ANNOTATION: The benefits from a centralized and competitive dispatch, compared with existing bilateral electricity trade agreements are determined to be about USD 100 million per year in the 12-nation Southern African Power Pool (SAPP). Generation, transmission, and costing variables are uniquely incorporated into a short-term cost minimizing mixed integer linear programming model, to determine the optimal unit commitment and dispatch across this 12-nation pool of the Southern African Development Community (SADC) region of Africa. Costs are minimized from increasing the use of existing hydropower facilities in the Democratic Republic of Congo, Zambia, and Mozambique and reducing fuel costs primarily in South Africa.

- [50] R L Bowen and R A Young. Financial and economic irrigation net benefit functions for Egypt’s northern delta. *Water Resources Research*, 21(9):1329–1335, 1985.

KEY: BoweYoun1985

- [51] Alan C Brent, David E C Rogers, Tsaletseng S M Ramabitsa-Siimane, and Mark B Rohwer. Application of the analytical hierarchy process to establish health care waste management systems that minimise infection risks in developing countries. *European Journal of Operational Research*, 181:403–424, 2007.

KEY: BrenEtAl2007

ANNOTATION: This paper focuses on the application of the analytical hierarchy process (AHP) technique in the context of sustainable development to establish and optimise health care waste management (HCWM) systems in rural areas of developing countries. This is achieved by evaluating the way in which the AHP can best be combined with a life cycle management (LCM) approach, and addressing a main objective of HCWM systems, i.e. to minimize infection of patients and workers within the system. The modified approach was applied to two case studies: the sub-Saharan African countries of South Africa and Lesotho. Quantitative weightings from the AHP are used to identify alternative systems that have similar outcomes in meeting the systems objective, but may have different cost structures and infection risks. The two case studies illustrate how the AHP can be used (with strengths and weaknesses) in environmental engineering decision support in developing countries.

- [52] Robert J Brent. A cost-benefit analysis of a condom social marketing programme in Tanzania. *Applied Economics*, 41(4):497–509, 2009.

KEY: Bren2009a

ANNOTATION: This article uses the revealed preference, willingness-to-pay approach to estimate the benefits in a cost-benefit analysis of a condom social marketing (CSM) programme in Tanzania. The demand curve used to derive the consumer surplus had unit elasticity and it was estimated from a cross-sectional sample of 1272 persons. People were willing to pay different prices for the condoms because perceived quality varied. Net benefits were close to zero for the minimum estimate that ignored external benefits. With external benefits included, the CSM programme was judged socially worthwhile with our best estimate producing a benefit-cost ratio ranging from 1.31 to 1.72.

- [53] Robert J Brent. A cost-benefit analysis of female primary education as a means of reducing HIV/AIDS in Tanzania. *Applied Economics*, 41(14):1731–1743, 2009.

KEY: Bren2009b

ANNOTATION: This article, uses panel data related to 20 Tanzania regions and 8 years to estimate the direct and indirect effects of female primary education on HIV/AIDS rates. A recursive framework for education, income and infections is employed, based on two autoregressive equations that allow us to obtain dynamic estimates of effectiveness. We find that the indirect effect working through changes in income outweighs the direct positive effect of education on infections, implying

that female education can be effective as an intervention to lower the disease in Tanzania. The estimates of effectiveness are then utilized to carry out a cost-benefit analysis of the education expenditures. The human capital approach is used to measure the benefits. Irrespective of the timing of the benefits and costs, and the discount rate alternatives we consider, our best estimates result in positive net-benefits, with benefit-cost ratios in the range 1.3-2.9.

- [54] Thomas Buchholz, Ewald Rametsteiner, Timothy A Volk, and Valerie A Luzadis. Multi criteria analysis for bioenergy systems assessments. *Energy Policy*, 37(2):484 – 495, 2009.

KEY: BuchEtAl2009

ANNOTATION: Sustainable bioenergy systems are, by definition, embedded in social, economic, and environmental contexts and depend on support of many stakeholders with different perspectives. The resulting complexity constitutes a major barrier to the implementation of bioenergy projects. The goal of this paper is to evaluate the potential of Multi Criteria Analysis (MCA) to facilitate the design and implementation of sustainable bioenergy projects. Four MCA tools (Super Decisions, DecideIT, Decision Lab, NAIADe) are reviewed for their suitability to assess sustainability of bioenergy systems with a special focus on multi-stakeholder inclusion. The MCA tools are applied using data from a multi-stakeholder bioenergy case study in Uganda. Although contributing to only a part of a comprehensive decision process, MCA can assist in overcoming implementation barriers by (i) structuring the problem, (ii) assisting in the identification of the least robust and/or most uncertain components in bioenergy systems and (iii) integrating stakeholders into the decision process. Applying the four MCA tools to a Ugandan case study resulted in a large variability in outcomes. However, social criteria were consistently identified by all tools as being decisive in making a bioelectricity project viable.

- [55] Thomas Buchholz and Izael Da Silva. Potential of distributed wood-based biopower systems serving basic electricity needs in rural Uganda. *Energy for Sustainable Development*, 14(1):56 – 61, 2010.

KEY: BuchSilv2010

ANNOTATION: Current efforts to improve electricity services in Uganda revolve around satisfying growing urban demand as well as stabilizing and boosting a low electricity supply. Although virtually non-existent, rural electrification is receiving very little attention. This paper investigates the potential of wood-based biopower fueled from coppicing shrubs on its feasibility to provide affordable basic electricity services to rural Ugandan households. Gasification was the specific technology we assessed. In the calculations, a worst case scenario was chosen for wood-based biopower to compete with alternative sources of electricity: Cost and land use estimates assumed a rather high household consumption (30 kWh/month), a low household size (8 persons), a low area productivity (3 oven-dried tons per ha per year), a low electrical conversion efficiency (15%) and a high demand competing for fertile land with the biopower system. Cost estimates considered a high biomass price (18.5 US\$/odt), a low capacity factor for the biopower system of 0.5 (therefore requiring installation of a larger unit) and high capital costs of 2300 US\$ per kW installed. Additional pressure on fertile land would be negligible. Such biopower systems can outcompete other sources of electricity from a micro and macro-economic standpoint when looking at the local scale. Results indicate that biopower can deliver better and more energy services at 47 US\$/yr and household or 0.11 US\$/kWh which is below current average costs for e.g. off-grid lighting in rural Ugandan households. Additionally, only this biopower option offers the ability to households, sell wood to the biopower system and contribute at least four times as much to the local economy than the other electricity options used as terms of comparison. Further research has to focus on developing business plans and loan schemes for such biopower options including sustainable fuelwood supply chains based on coppicing shrubs which have the ability to contribute to agricultural site improvements. The approach outlined in this paper can further serve as a general framework to compare different options of electricity production across technologies and fuel sources especially for rural development purposes incorporating a multitude of aspects.

- [56] Graeme Buckley. Microfinance in Africa: Is it either the problem or the solution? *World Development*, 25(7):1081–1093, July 1997.

KEY: Buck1997

ANNOTATION: This article is based on research undertaken on micro enterprises in the informal sector in Kenya, Malawi and Ghana. It seeks to provoke critical reflection on the uncritical enthusiasm that lies behind much proselytizing of microfinance for informal sector micro enterprise. It questions whether the extensive donor interest in micro enterprise finance really addresses the problems of micro entrepreneurs or whether it offers the illusion of a quick fix. It suggests that

the real problems are more profound and cannot be tackled solely by capital injections but require fundamental structural changes of the socioeconomic conditions that define informal sector activity and a fuller understanding of the ‘psyche’ of informal sector entrepreneurs.

- [57] Hans-Jürgen Buss and Ernst-August Nuppenau. More sustainable range use in semi-arid eco-systems through adapted management: A case study on Namibian farms based on bio-economic models. In *Deutscher Tropentag, Deutscher Tropentag 2002* Witzenhausen, October 2002. Deutscher Tropentag, Deutscher Tropentag.

KEY: BussNupp2002

ANNOTATION: This paper deals with bio-economic modelling of potentially degraded range land in Namibia. It outlines the methodological background, presents a modelling approach in GAMS and offers first results. We show how bush encroachment can be modelled and how various factors, like interest rates and costs of combating bushes, impact on farm behaviour and the environment. In particular the prevalence of bush and range quality decline are a focus of the paper.

- [58] Giuliano Cecchi, William Wint, Alexandra Shaw, Andrea Marletta, Raffaele Mattioli, and Timothy Robinson. Geographic distribution and environmental characterization of livestock production systems in Eastern Africa. *Agriculture, Ecosystems & Environment*, 135(1-2):98 – 110, 2010.

KEY: CeccEtAl2010

ANNOTATION: The central role played by livestock in the livelihoods of rural households in the developing world is seldom fully appreciated by policy makers, development agencies and donors. Knowledge gaps in the geographic distribution and environmental determinants of farming systems, especially if viewed through the livestock lens, compound this problem. We have produced a map of pastoral, agro-pastoral and mixed farming systems across Eastern Africa, by analysing datasets collected in the framework of livelihood analysis. Input data were gathered between 2000 and 2007 by various emergency and development agencies for Djibouti, Eritrea, Kenya, Somalia, Uganda and parts of Ethiopia and Sudan. A quantitative definition of the production systems is adopted, based on the ratio of livestock- to crop-derived income. The resulting livelihood-based map of livestock production systems was compared through correspondence analysis to an alternative livestock production systems map, produced independently from environmental data. Convergence between the two mapping approaches was evident. The geographic distribution of the livestock production systems was also modelled using multivariate analysis of remotely sensed and other geospatial datasets. Models show high statistical accuracy, and were thus used to fill the gaps in the observed distribution of livestock production systems. Finally, selected environmental factors underpinning the systems (agro-climatology, human and livestock populations and land cover) were analysed in detail, enabling the livestock production systems to be characterized in terms of them. The regional scope of the map, as well as its direct link with a vast amount of livelihood information, render it a valuable tool for a range of development and research applications, including those related to global change.

- [59] E C K Chanda. An application of integer programming and simulation to production planning for a stratiform ore body. *Mining Science & Technology*, 11(2):165–172, 1990.

KEY: Chan1990

ANNOTATION: In this paper a computerized model for short-term production scheduling in a typical block caving mine with a stratiform ore body is presented. By combining simulation with mixed integer programming, it has been possible to model realistically the problem of scheduling draw points for production at the Chingola Mine of Zambia Consolidated Copper Mines Limited. The model is based on a given layout of the mining block which is considered fixed during the planning period. The model is intended for use by planning engineers or mine captains working with personal computers. In comparison with manual scheduling, the computerized model has been found to be faster and generates near-optimal schedules.

- [60] L Chemane, L Ekenberg, O Popov, and T Cossa. A multi-criteria decision model (MCDM) for selecting internet access technologies: A case study in Mozambique. In *EUROCON 2005 - The International Conference on Computer as a Tool, (Belgrade) II, art. no. 1630311*, pages 1738–1741, 2005.

KEY: ChemEtAl2005

ANNOTATION: The development of Internet, networking and access technologies is providing a wide variety of Internet interconnection alternatives. The availability of several options in the Internet interconnection market makes it difficult to select the ‘optimal’ alternative for a specific enduser in a specific context. A MCDM based model for structuring and solving the Internet access technologies selection decision problem is proposed. The applicability and validation of this approach is demonstrated in a case study in Mozambique.

- [61] S Chiremba and W Masters. The experience of resettled farmers in Zimbabwe. *African Urban Quarterly*, 7:91–109, 2003.
- KEY: ChirMast2003
- ANNOTATION: This study assesses the relative productivity of smallholder farmers in Zimbabwe's land reform and resettlement programme. We use a panel of survey data collected in 1992, 1993, 1996, and 1997 from up to 400 resettled households, who in 1981-84 had been moved onto previously large-scale commercial farms in three distinct agro-ecological regions. A sub-sample of 166 households were surveyed in all four years, and for 1997 we have data from a comparable survey of 147 farmers in communal areas. Using these data, we ask whether and how the resettled farmers' productive efficiency might have converged to their area's efficiency frontier over time, and whether particular farmer characteristics or institutional interventions might have helped them to improve faster. Applying Data Envelopment Analysis methods to measure productive efficiency, we find that although individual farmers often moved towards higher efficiency levels, there was no trend towards the frontier, and farmers' improvements were not consistently correlated with receiving formal credit or extension services, having more experience or education, or using more farm equipment. In sum, despite the relatively large and uniform land area available to each farmer, they had widely varying productivity levels, not overcome by conventional farm services.
- [62] John M Christensen and Rene Victor Valqui Vidal. Project evaluation for energy supply in rural areas of developing countries. *European Journal of Operational Research*, 49:230–246, November 1990.
- KEY: ChriVida1990
- ANNOTATION: This paper reports the methodological experiences of the project: Energy Supply Technologies in Developing Countries, carried out in collaboration with the Department of Energy, Zambia. Existing methods for project evaluation, based on cost-benefit analysis, will be briefly presented, particularly as regards their inadequacy for assessing energy projects in rural areas. An alternative practical and PC-based approach will be presented in which emphasis is placed on the problem formulation phase, including the socio-economic, cultural and political aspects of the problem. This approach has been prepared for training purposes. Finally, some methodological thoughts based on our practical experiences will be presented and our future work will be briefly discussed.
- [63] James E Clayson. How relevant is operational research to development? The case of Kenyan industry. *Journal of the Operational Research Society*, 31(4):293–299, April 1980.
- KEY: Clay1980
- ANNOTATION: This paper proposes that the debate over O.R.'s role in development can be advanced by looking at a specific industrial environment. The Kenyan example suggests that for O.R. to make a contribution to this developing society it must: first, be defined as broadly as possible so as to include the most basic problem-solving techniques, and second, contribute to the diffusing of these techniques throughout the economy. O.R. should be viewed less as the province of an elite group of specialists— and more as a common resource available to managers at any level of industry. O.R. educators in developing nations can *democratise* quantitative techniques by incorporating them into such traditional business disciplines as accounting, marketing, and production. These courses should stress problem-solving and rely on cases drawn from local experiences. The paper ends by describing a pilot project, the Case Research and Documentation Centre, which is designed to promote more pragmatic management education and research in Kenya.
- [64] D D Cleevly. *Regional structure and telecommunications demand: A case study of Kenya*. PhD thesis, University of Cambridge, Cambridge, U.K., 1982.
- KEY: Clee1982
- [65] D D Cleevly and Geoff Walsham. Telecommunications models: planning for regional development in Less Developed Countries (LDCs). *Telecommunications Policy*, 4:108–118, 1980.
- KEY: CleeWals1980
- ANNOTATION: The aim of telecommunications policy in the less developed countries should be to contribute to general development goals, but the links between economic development and telecommunications are not clearly understood. The authors suggest a dual approach to this problem. First, this involves the construction of models of demand based on the interaction between regional economic development and telecommunications use. Second, corporate models are required to explore the feasibility of particular supply strategies. The progress of practical work in these areas is described and includes the results of some specific research in Kenya.
- [66] Barney Cohen. The emerging fertility transition in Sub-Saharan Africa. *World Development*, 26(8):1431–1461, August 1998.

KEY: Cohe1998

ANNOTATION: This paper summarizes the recent evidence on levels, trends and differentials in achieved fertility, nuptiality, and contraceptive use in sub-Saharan Africa. Drawing from a wide variety of data sources, not all of which have been readily available in the past, an interesting picture of fertility decline emerges, one that is quite at odds with the popular perception of stationary or very limited fertility decline. A fairly widespread decline in fertility is currently underway across Africa. Moderate to large declines in fertility have already taken place in Kenya, Rwanda, Zimbabwe, Botswana, South Africa, and Côte d'Ivoire, with smaller declines observed in Malawi, Tanzania, Zambia, Cameroon, Central African Republic, Burkina Faso, Gambia, Ghana, Mauritania, Senegal, and Sierra Leone. The driving forces behind these changes are later marriage and the greater use of modern contraception. A unique characteristic of African transitions appears to be the extent to which contraceptives are being used to space rather than to limit births.

- [67] Michael Coleman, Brian Sharp, Ishen Seocharan, and Janet Hemingway. Developing an evidence-based decision support system for rational insecticide choice in the control of African malaria vectors. *Journal of Medical Entomology*, 43(4):663–668, July 2006.

KEY: ColeEtAl2006

ANNOTATION: The emergence of Anopheles species resistant to insecticides widely used in vector control has the potential to impact directly on the control of malaria. This may have a particularly dramatic effect in Africa, where pyrethroids impregnated onto bed-nets are the dominant insecticides used for vector control. Because the same insecticides are used for crop pests, the extensive use and misuse of insecticides for agriculture has contributed to the resistance problem in some vectors. The potential for resistance to develop in African vectors has been apparent since the 1950s, but the scale of the problem has been poorly documented. A geographical information system-based decision support system for malaria control has recently been established in Africa and used operationally in Mozambique. The system incorporates climate data and disease transmission rates, but to date it has not incorporated spatial or temporal data on vector abundance or insecticide resistance. As a first step in incorporating this information, available published data on insecticide resistance in Africa has now been collated and incorporated into this decision support system. Data also are incorporated onto the openly available Mapping Malaria Risk in Africa (MARA) New data, from a range of vector population-monitoring initiatives, can now be incorporated into this open access database to allow a spatial understanding of resistance distribution and its potential impact on disease transmission to benefit vector control programs.

- [68] C Conteh and F L K Ohemeng. The politics of decision making in developing countries. *Public Management Review*, 11(1):57–77, 2009.

KEY: ContOhem2009

ANNOTATION: Decision making in developing countries has not been accorded the needed attention by policy studies scholars. The general perception among these scholars is that the policy making process is externally driven, especially when the policy involves economic decision. Using privatization as a case study, the article examines policy making in Botswana and Ghana. It argues that it is wrong to assume that all developing countries are merely 'policy hooks' in the decision making game of the international community. It shows that some countries have the capacity to develop their own policies depending on their level of dependency on the international community.

- [69] L B Coop, B A Croft, C F Murphy, and S F Miller. Decision support system for economic-analysis of grasshopper treatment operations in the African Sahel. *Crop Protection*, 10(6):485–495, December 1991.

KEY: CoopEtAl1991

ANNOTATION: A decision support system for benefit/cost analysis of chemical treatment of the Senegalese grasshopper, *Oedaleus senegalensis* (Krauss) (OSE), was created to assist in the training, analysis, and management of grasshopper treatment programmes. The system, known as GHLSIM, has linked simulation models, databases, and a user interface. Millet and sorghum phenology and yields are estimated by an FAO (Food and Agriculture Organization, United Nations) soil water deficit model. Outputs from the PRIFAS (Programme de Recherches Interdisciplinaire Francais sur les Acridiens du Sahel) OSE biomodel, including daily grasshopper life stages and favourability for development, are converted to density estimates using survey data, oviposition rates, and natural and insecticide-caused mortality. Crop loss is estimated through crop injury units - a function of grasshopper stage densities, consumption rates, crop preference, crop stage susceptibility, and non-crop vegetation greenness. Second-year benefits of treatment are estimated from end-of-season egg-pod densities. The model was calibrated using published economic thresholds for four crop stages. Yield increases from a late-season grasshopper aerial treatment campaign,

22 September - 19 October 1987, at 13 sites in eastern Chad were estimated at 33% +/- 20% (s.e.). Benefit/cost ratios were 2.6 +/- 0.5 for the first season, and 3.8 +/- 0.7 with second-year effects added. The analysis indicated that optimal timing was 5-10 days earlier than the actual treatments. Crop yield reports from treated and non-treated areas, a crop loss assessment conducted in Batha, Chad in October 1987 and a break-even analysis provide further evidence that the campaign was successful and cost-effective at most sites, as indicated by model results.

- [70] R. Couth and C. Trois. Waste management activities and carbon emissions in Africa. *Waste Management*, 31(1):131-137, 2011.

KEY: CoutTrois2011

ANNOTATION: This paper summarizes research into waste management activities and carbon emissions from territories in sub-Saharan Africa with the main objective of quantifying emission reductions (ERs) that can be gained through viable improvements to waste management in Africa. It demonstrates that data on waste and carbon emissions is poor and generally inadequate for prediction models. The paper shows that the amount of waste produced and its composition are linked to national Gross Domestic Product (GDP). Waste production per person is around half that in developed countries with a mean around 230kg/hd/yr. Sub-Saharan territories produce waste with a biogenic carbon content of around 56% (+/-25%), which is approximately 40% greater than developed countries. This waste is disposed in uncontrolled dumps that produce large amounts of methane gas. Greenhouse gas (GHG) emissions from waste will rise with increasing urbanization and can only be controlled through funding mechanisms from developed countries.

- [71] G Coyle. The practice of system dynamics: milestones, lessons and ideas from 30 years experience. *System Dynamics Review*, 14(4):343-365, Winter 1998.

KEY: Coyl1998

ANNOTATION: The paper was written to respond to the honour of the conferment of the first Lifetime Achievement Award of the System Dynamics Society. A brief review of some of the author's early experiences suggests that it is valuable to have done other things as well as system dynamics. An approach to system dynamics modelling based on influence diagrams is described, leading to the concept of the cone of diagrams. That is illustrated by two views of a mining company. The use of performance indices to measure policy outcomes is illustrated for the mining company, showing how competing actors can both achieve their objectives. Further influence diagrams are developed for defence problems, the millennium 'time bomb' in a utility company and for the catastrophe of Angola. In each case, the diagram produces policy insights without the necessity of simulation. There is a discussion of the possible limits to quantification in system dynamics. The role of optimisation in system dynamics is examined and illustrated by two cases. The links between system dynamics and other methodologies for the study of the future are considered and exemplified. Finally, the author offers some thoughts on the future of system dynamics.

- [72] Peter Crossley. An expert system for the prediction of total vehicle and road operating costs in developing countries. *Computers and Electronics in Agriculture*, 21(3):169 - 180, 1998.

KEY: Cros1998

ANNOTATION: The results of field work on road deterioration in Tanzania and of soil bin laboratory work on rut formation are outlined. The development of an expert system to predict total road and vehicle costs is described. Validation of and results from the program are given. It is concluded that earth road maintenance is a continuing problem and that the role of agricultural vehicles may increase. A copy of the expert system is available on request (two 3.5-inch discs) for evaluation purposes only.

- [73] Hulya Dagdeviren and Simon A. Robertson. Access to water in the slums of sub-saharan africa. *Development Policy Review*, 29(4):485-505, 2011.

KEY: DagdRobe2011

- [74] Nicole Darmon, Elaine Ferguson, and André Briend. Linear and nonlinear programming to optimize the nutrient density of a population's diet: an example based on diets of preschool children in rural Malawi. *American Journal of Clinical Nutrition*, 75(2):245-253, February 2002.

KEY: DarmEtAl2002

ANNOTATION: Background: Food consumption surveys are often used to detect inadequate nutrient intakes but not to determine whether inadequate nutrient intakes are due to suboptimal use of locally available foods or to insufficient availability of nutrient-dense foods. Objectives: The objectives were to describe the use of linear programming as a method to design nutrient-adequate diets of optimal nutrient density and to identify the most stringent constraints in nutritional recommendations and food consumption patterns in a population's diet. Design: This analysis was

conducted with the use of food consumption data collected during 2 seasons from rural Malawian children aged 36 y. Linear programming was used to select diets based on local foods that satisfied a set of nutritional constraints while minimizing the total energy content of the diet. Additional constraints on daily intakes of foods and food groups were also introduced to ensure that the diets were compatible with local food patterns. The strength of the constraints was assessed by analyzing nonlinear programming sensitivity. Results: In the harvest season, it was possible to satisfy nutritional recommendations with little departure from the local diet. In the nonharvest season, nutritional adequacy was impaired by the low availability of riboflavin- and zinc-rich animal or vegetable foods and by the high phytate content of other foods. Conclusions: This analysis suggests that nutrition education may help improve the diets of children in the harvest season, whereas changes in the range of available foods might be needed in the nonharvest season. Linear and nonlinear programming can be used to formulate recommendations with the use of data from local food consumption surveys.

- [75] Simon Davies and James Davey. A regional multiplier approach to estimating the impact of cash transfers on the market: The case of cash transfers in rural Malawi. *Development Policy Review*, 26(1):91–111, 2008. publisher: Blackwell Publishing Ltd; ISSN: 1467-7679; also available as: [/dx.doi.org/10.1111/j.1467-7679.2008.00400.x](https://dx.doi.org/10.1111/j.1467-7679.2008.00400.x).
KEY: DaviDave2008

ANNOTATION: This article analyses the impact on the local economy of an emergency cashtransfer programme in rural Malawi. The results are of interest, given the growing use of cash transfers as development aid as well as the increasing popularity of such transfers as a form of social protection across subSaharan Africa. It uses a form of social accounting matrix to show that there are widespread benefits for the regional economy as a whole (with multiplier estimates of 2.02 to 2.45), especially during the most lean periods of the year, and for small farmers and small businesses in particular, as this is where poorer households' purchases are focused; education and health also benefit.

- [76] Vanda De Angelis, Mariagrazia Mecoli, Chris Nikoi, and Giovanni Storchi. Multiperiod integrated routing and scheduling of World Food Programme cargo planes in Angola. *Computers & Operations Research*, 34(6):1601–1615, June 2007.

KEY: DeAnEtAl2007

ANNOTATION: This paper deals with the weekly planning of WFP emergency deliveries of food aid by air in Angola, where planes are required to travel back and forth between depots and clients, deliver entire loads to the client reached every time and, at night, park at a depot, subject to parking space availability. An ILP model has been formulated, called the VRVDFL model, tailored for the real problem, and has been solved. The computational experience is reported.

- [77] V De Brouwere, W Van Lerberghe, B Criel, and M Van Dormael. Entre gestion scientifique et recherche-action: le probleme de l'hyperconsommation des médicaments a Kasongo (Zaire). [Between scientific management and research-action: the problem of overconsumption of drugs in Kasongo (Zaire)]. *Cahiers de Sociologie et de Démographie Médicales*, 36(2):141–170, April–June 1996.

KEY: BrouEtAl1996

ANNOTATION: A Primary Health Care (PHC) system may be effective and efficient to the extent that essential drugs are available in health services and financially accessible to the population. In developing countries, besides the difficulties related to supplying health services with adequate amounts of drugs, the control of drug consumption is one of the frequent problems encountered by health authorities. Literature is relatively abundant in the field of rationalization of the diagnosis and drug prescription processes, and also in the field of drug financing mechanisms; publications are however rather scarce when topics related to corruption or drug misappropriation are concerned. The case study submitted hereafter reports a drug overconsumption problem in the health centres (HC) of the Kasongo district (Zaire). Despite the existence of direct control mechanisms as well as indirect ones (monitoring of drug consumption by HC), the problem has been identified belatedly. The district staff then used a step-by-step analysis of the HC drug consumption profiles; this analysis allowed to demonstrate that misappropriation would be the most plausible hypothesis. In order to solve the misappropriation problem-the consequences of which jeopardized the functioning of the very health system-the district staff chose to involve the nurses, in charge of the HC, in the entire problem-solving process. This participative approach, involving different actors as partners, allowed to deepen the situation analysis and to elaborate solutions congruent with PHC principles and acceptable to all concerned.

- [78] Hugo De Groot, Bernard Vanlauwe, Esther Rutto, George D. Odhiambo, Fred Kanampiu, and Zeyaur R. Khan. Economic analysis of different options in integrated pest and soil fertility management in maize systems of Western

Kenya. *Agricultural Economics*, 41(5):471–482, 2010. publisher: Blackwell Publishing Inc; ISSN: 1574-0862; also available as: [//dx.doi.org/10.1111/j.1574-0862.2010.00459.x](https://dx.doi.org/10.1111/j.1574-0862.2010.00459.x).

KEY: GrooEtAl2010

ANNOTATION: Abstract The major biotic constraints to the production of maize, the major staple food in Western Kenya, are field pests such as Striga and stem borers, and low soil fertility. To counter these constraints, new cropping systems have been developed, including push-pull, rotations with promiscuous soybean varieties and green manure crops, and imidazolinone resistant- (IR-) maize. To analyze the technical and economic performance of these technologies, both with and without fertilizer, on-farm researcher-managed long-term trials were implemented over six seasons in two sites each in Vihiga and Siaya districts of Western Kenya. The economic results, based on marginal analysis using a multioutput, multiperiod model, show that the new cropping systems with fodder intercropping (push-pull) or soybean rotations were highly profitable. Push-pull is more profitable but requires a relatively high initial investment cost. Green manure rotation, IR-maize, and fertilizer all increased yields, but these investments were generally not justified by their increased revenue. We argue that research on rotation and cropping systems to tackle pest and soil fertility problems in Africa deserve more attention. This will require increased collaboration between agronomists and economists to set up long-term experiments with new cropping systems to develop proper economic models.

- [79] Uwe Deichmann, Craig Meisner, Siobhan Murray, and David Wheeler. The economics of renewable energy expansion in rural sub-Saharan Africa. *Energy Policy*, 39(1):215–227, 2011.

KEY: DeicEtAl2011

ANNOTATION: Accelerating development in Sub-Saharan Africa will require massive expansion of access to electricity—currently reaching only about one third of households. This paper explores how essential economic development might be reconciled with the need to keep carbon emissions in check. We develop a geographically explicit framework and use spatial modeling and cost estimates from recent engineering studies to determine where stand-alone renewable energy generation is a cost effective alternative to centralized grid supply. Our results suggest that decentralized renewable energy will likely play an important role in expanding rural energy access. However, it will be the lowest cost option for a minority of households in Africa, even when likely cost reductions over the next 20 years are considered. Decentralized renewables are competitive mostly in remote and rural areas, while grid connected supply dominates denser areas where the majority of households reside. These findings underscore the need to decarbonize the fuel mix for centralized power generation as it expands in Africa.

- [80] Feyisa Demie. *An empirical study of technological change in the Ethiopian highland farming systems*. PhD thesis, Wye College, London, UK, 1987.

KEY: Demi1987

ANNOTATION: One of the major policy issues facing agricultural planners in Ethiopia is that of how to raise the productivity of smallholder agriculture. Improving the productivity of traditional agriculture requires at the very least an understanding of resource use patterns and technological change. Yet there has been little empirical research in Ethiopia which helps policy makers to determine existing development opportunities and to formulate a longer term agricultural development strategy. This study was designed to explore the means and possibilities of improving existing farming systems through the introduction of new technological packages. The principal hypothesis investigated is that low productivity in Ethiopian agriculture is mainly due to the use of traditional technology, and increases in farm productivity are most likely to arise from technological improvements in agricultural production. The data for the study was taken from the farm management surveys and on-farm experimental trials. Two methodological approaches were used to test the above hypothesis in the highland farming systems. First, an empirical investigation was undertaken to draw lessons from the experience of the impact of such technological transformation that has occurred. Methodological and data problems in technological change studies were discussed. Any shift in parameters in the production function was estimated. The relative efficiency of small and large farms was examined using translog production function. It was concluded that the introduction of new technology has increased farm income considerably. However, the findings of the relative efficiency of resource use has shown the weakening of the generally accepted inverse relationship of farm size and productivity in peasant agriculture. The extent to which appropriate economic analytical tools are needed and misleading policy implications that can be drawn from agricultural development theory are also highlighted. Secondly, a formal modelling

of the farming systems, within the framework of linear programming was carried out to examine development opportunities under existing and alternative technologies. Optimum farm plans were generated for representative farms under existing farming systems. However, a comparison of actual and optimum farm gross margin does not reveal substantial room for improvement. From this base it was argued that a necessary condition for continued development is the introduction of new technologies. In a series of simulation experiments using recommended bio-chemical and mechanical technology, a number of technological possibilities open to policy makers interested in improving productivity of agriculture were identified. The effects of the alternative technologies on farm income and resource productivity were discussed. The sensitivity of the simulated results was assessed. The major findings of the thesis show that the potential for increasing production and alleviation of rural poverty lies in the introduction of a range of alternative technologies in the form of HYV, fertilizers, herbicides and combine threshers/harvesters. Based on this study, it is suggested that planners and policy makers should sustain research and design strategies and programmes which would enhance smallholder agricultural development in Ethiopia.

- [81] Feyisa Demie. Size of holding and productivity in the Ethiopian highland farming systems. Discussion paper, Department of Economics, Egerton University, 1988.

KEY: Demi1988

ANNOTATION:

- [82] Hermann Dick, Thomas Mayer, David Vincent, and Sanjeev Gupta. The short-run impact of fluctuating primary commodity prices on three developing economies: Colombia, Ivory Coast and Kenya. *World Development*, 11(5):405–416, May 1983.

KEY: DickEtAl1983

ANNOTATION: Computable general equilibrium models are used to study the short-run impact of fluctuating primary commodity prices on the economies of Colombia, Ivory Coast and Kenya. The results indicate that these economies are destabilized by primary commodity price fluctuations unless governments act to hold real domestic absorption constant. To achieve this, however, would require foreign exchange reserves in excess of the level normally available to these governments for the purpose of stabilizing domestic economic activity.

- [83] Enoch M Dlamini, Sidney Dhlamini, and Sindy Mthimkhulu. Fractional water allocation and reservoir capacity sharing concepts: An adaptation for the Komati basin. *Physics and Chemistry of the Earth*, 32(15–18):1275–1284, 2007.

KEY: DlamEtAl2007

ANNOTATION: This paper presents an adaptation of fractional water allocation and reservoir capacity sharing (FWARCS) concepts for application in the Komati Basin, a river system shared between South Africa, Swaziland and Mozambique. Many traditional methods for allocating water are based on volume-per-unit-time allocation that is supplied at some level of assurance and managed using priority-based reservoir and river system operating rules, as well as on the “use it or lose it” principle, which is considered exclusive by water users as it leaves them out of the management of their water allocations. In the Komati Basin, these traditional methods of water allocation led to frequent conflicts among users and with water managers. However, the introduction of the modified FWARCS, which assigns available water in the system to water users according to the proportions of their water entitlements and allows water to be banked in reservoirs, appears to be a solution to some of these problems. This method allows water users to decide when and how much of that entitlement they may use. Since the implementation of the modified FWARCS technique in the Komati Basin in 2002, the regulation, transparency and efficiency of operating the system improved and subsequently the number of disputes over water has declined. South Africa improved from an overuse of 8.2 Mm(3) in 2002/03 water year to realize a saving of 29.5 Mm(3) in 2005/06. Similarly, Swaziland improved from an overuse of 3.9 Mm(3) in 2002/03 to achieve a saving of 14.6 Mm(3) in 2005/06. Users have recognised and embraced the transparency and flexibility of the modified FWARCS. They choose, as the need and opportunity arise, when and how much water they utilise, whether to “bank” and/or “trade” the water they save subject to the conditions of their entitlements. The implementation of the modified FWARCS was also made successful by the existence of proper institutional structures, appropriate decision support tools, good water measurement infrastructure and reliable water accounting systems. The establishment, development and utilization of these elements of water management, as well as the challenges encountered in relation to the adoption of modified FWARCS in the Komati Basin are discussed in this paper.

- [84] A Dorward. Farm size and productivity in Malawian smallholder agriculture. *Journal of Development Studies*, 35(5):141–161, 1999.

KEY: Dorw1999

ANNOTATION: This article contributes to the limited literature on farm size and productivity in smallholder agriculture in sub-Saharan Africa. Farm survey data, and the results from a linear programming farm-household model, provide evidence for a positive relationship between farm size and productivity in both labour-scarce and land-scarce smallholder farming in Malawi during the 1980's. The absence of an inverse relationship is explained in terms of failures in land, capital and produce markets with acute capital constraints, which affect both capital and labour inputs on smaller farms. Implications for rural development policies are discussed.

- [85] A Dorward. Modelling embedded risk in peasant agriculture: methodological insights from northern Malawi. *Agricultural Economics*, 21(2):191–203, 1999.

KEY: Dorw1999b

ANNOTATION: Using a linear-programming model of farming systems in northern Malawi, the conditions under which peasant farm-household models may need to allow for embedded risk are investigated. Tactical, sequential responses to uncertainty are found to be more important to labour-scarce households with limited access to capital and to credit markets. Compared with semi-sequential programming, discrete stochastic programming (DSP) provided more efficient solutions for problems involving embedded risk. There may be intuitive advantages in presenting results from DSP models in terms of a semisequential strategy.

- [86] Massimo Dragan, Enrico Feoli, Michele Ferneti, and Woldu Zerihun. Application of a spatial decision support system (SDSS) to reduce soil erosion in northern Ethiopia. *Environmental Modelling & Software*, 18(10):861 – 868, 2003.

KEY: DragEtAl2003

ANNOTATION: A spatial decision support system (SDSS) based on multi-criteria and multi-objective decision analysis is applied in a case study in Ethiopia to reduce soil erosion on the basis of reallocation of crops according to their capacity to protect the soil. The case study is carried out in the Adwa district. The SDSS has been implemented using the widespread GIS software IDRISI 32 (release 2) and with the direct involvement of local stakeholders in defining factors and constraints. These are based on land cover-land use, altitude, potential erosion, proximity to roads, water and the relative soil protective capacity of each crop species. A reduction of soil loss from an average of $4.5 \text{ t ha}^{-1} \text{ yr}^{-1}$ to values below the risk threshold of soil degradation ($1 \text{ t ha}^{-1} \text{ yr}^{-1}$) would be achieved through the application of the SDSS results. The biggest impediment to the reallocation exercise, however, is the shortage of cultivable land suitable for cultivation.

- [87] J M Due, P Anandajayasekeram, M White, and T E Gillard-Byers. Beans in two contrasting farming systems in Morogoro region, Tanzania, 1980. Technical Report 83.3, University of Dar es Salaam, Economic Research Bureau, 1983.

KEY: DueEtAl1983

ANNOTATION: The differences in farming systems in two areas of Morogoro Region, Tanzania, in which maize and beans are important components, are documented. Although traditional agriculture is the norm in both areas and few purchased inputs are used, there are significant differences. The farming systems differed in that Mgeta households produced vegetables, beans, cabbage, cauliflower, and lettuce for market as well as maize and sorghum for home consumption, while Kilosa families produced primarily cereals, some beans, cotton, and sunflower. The study analyzes the value of total production, consumption, and sale of crops, household expenditure and labour utilization, emphasizing female labour contribution. A linear programming model is formulated to show that benchmark households can meet recommended minimum levels of calories and utilizable protein.

- [88] J M Due, M White, and T Rocke. Beans in the farming systems in two regions of Tanzania, 1980-82. Technical Report 4, Department of Rural Economy, Sokoine University of Agriculture, Morogoro, Tanzania, 1985.

KEY: DueEtAl1985

ANNOTATION: The results of research undertaken to provide baseline and farming systems data for 2 regions of Tanzania between 1980-82 are summarized. The general economy of Tanzania during this time period and the importance of beans in farming systems are described. The adequacy of provision of minimum recommended levels of calories and protein from home-produced food/family is discussed as well as the development of a linear programming model which would provide these levels while maximizing farm income.

- [89] Ike C Ehie and Colin O Benjamin. Integrated multiobjective planning model: a case study of the Zambian copper mining industry. *European Journal of Operational Research*, 68:160–172, 1993.

KEY: EhieBenj1993

ANNOTATION: This study outlines a planning methodology that formally integrates major societal

dimensions with mathematical programming in industry planning for a low-income developing country. An integrated approach involving the Analytic Hierarchy Process (AHP) and Linear Goal Programming (LGP) is employed. Development objectives are classified under economic, technological, social and political factors and are prioritized using the AHP according to their degree of importance. The priority structure is incorporated into the LGP framework to develop a multiobjective planning model. The application of the model is demonstrated using data from an export-oriented, semi-industrial and dominant copper mining sector in a low-income developing country in Sub-Saharan Africa.

- [90] Ike C Ehie, Colin O Benjamin, Yildirim Omurtag, and L Clarke. Prioritizing development goals in low-income developing countries. *Omega*, 18:185–194, 1990.

KEY: EhieEtA11990

ANNOTATION: This paper outlines a systematic approach to prioritizing the multiple and often conflicting development goals and objectives in a typical low-income developing country (LDC). First, a hierarchy of development goals and objectives is developed from an extensive review of the literature. Then, Analytic Hierarchy Process is utilized to analyze the judgement elicited from World Bank experts and a priority structure established reflecting the perceived importance of these development goals and objectives. This methodology can assist development planners in LDCs in formulating development plans consistent with national objectives. (The paper is a general study of several sub-Saharan nations.)

- [91] M C Eisler, J W Magona, N N Jonsson, and C W Revie. A low cost decision support tool for the diagnosis of endemic bovine infectious diseases in the mixed coplivestock production system of sub-Saharan Africa. *Epidemiology and Infection*, 135(1):67–75, January 2007.

KEY: EisIEtA12007

ANNOTATION: Diagnosis and treatment of endemic infectious disease is crucial for productivity of cattle in rural sub-Saharan Africa, but shortages of trained veterinary professionals necessitate support for less well-trained cadres of animal health worker. A Delphi survey of veterinary experts provided quantitative information on key clinical signs associated with eight endemic bovine diseases, then heuristics and dendrogram analysis identified a reduced sign set to be incorporated in a diagnostic decision support tool implemented as a simple colour-banded card. One hundred and seventy disease-sign questionnaire returns were obtained from 32 veterinary research scientists and 14 veterinary practitioners. Preliminary validation of the decision support tool for 16 prototypical cases resulted in correct diagnosis over 90% of the time. The card potentially serves as a training aid and aide-memoire, and could improve the diagnostic competence of animal healthcare providers.

- [92] Donatus U Ekwueme, Bruce G Weniger, and Robert T Chen. Model-based estimates of risks of disease transmission and economic costs of seven injection devices in sub-Saharan Africa. *Bulletin of the World Health Organisation*, 80(11):859–870, November 2002.

KEY: EkwuEtA12002

ANNOTATION: OBJECTIVE: To investigate and compare seven types of injection devices for their risks of iatrogenic transmission of bloodborne pathogens and their economic costs in sub-Saharan Africa. METHODS: Risk assumptions for each device and cost models were constructed to estimate the number of new hepatitis B virus (HBV) and human immunodeficiency virus (HIV) infections resulting from patient-to-patient, patient-to-health care worker, and patient-to-community transmission. Costs of device purchase and usage were derived from the literature, while costs of direct medical care and lost productivity from HBV and HIV disease were based on data collected in 1999 in Côte d'Ivoire, Ghana, and Uganda. Multivariate sensitivity analyses using Monte Carlo simulation characterized uncertainties in model parameters. Costs were summed from both the societal and health care system payer's perspectives. FINDINGS: Resterilizable and disposable needles and syringes had the highest overall costs for device purchase, usage, and iatrogenic disease: median USD 26.77 and USD 25.29, respectively, per injection from the societal perspective. Disposable-cartridge jet injectors and automatic needle-shielding syringes had the lowest costs, USD 0.36 and USD 0.80, respectively. Reusable-nozzle jet injectors and auto-disable needle and syringes were intermediate, at USD 0.80 and USD 0.91, respectively, per injection. CONCLUSION: Despite their nominal purchase and usage costs, conventional needles and syringes carry a hidden but huge burden of iatrogenic disease. Alternative injection devices for the millions of injections administered annually in sub-Saharan Africa would be of value and should be considered by policy-makers in procurement decisions.

- [93] RD Ellis and M Tshawuka. Development and performance of revised cane loading and delivery systems on an estate in Swaziland. In Hogarth, DM, editor, *International Society of Sugar Cane Technologists, Volume II, Proceedings*, pages

230–234, Box 5611, Private Mail Bag, Mackay, 4741, Australia, 2001. Int Soc Sugar Cane Technologists, Australian Society of Sugar Cane Technologists.

KEY: ElliTsha2001

- [94] Bodil Elmqvist, Eltighani Mirghani Elamin, Andrew Warren, and Lennart Olsson. A traditional agroforestry system under threat: an analysis of the gum arabic market and cultivation in the Sudan. *Agroforestry Systems*, 64(3):211–218, September 2005.

KEY: ElmqEtAl2005

ANNOTATION: The main aim of this study is to review the environmental and socioeconomic sustainability of the gum arabic farming system in central Sudan. A further aim is to analyse some of the main factors influencing production in recent decades in order to understand the future trade potential and consequently the smallholder livelihood. The study shows that end-user imports of gum arabic have increased during recent decades. Gum arabic is mainly for uses such as soft drinks, confectionery, and pharmaceuticals. However, even with this increased demand the production in Sudan, the main country of production, is declining. The producers, mainly smallholders, suffer from fluctuating prices. If the gum arabic farming system should be able to provide the environmental benefits of improved soil fertility and the socioeconomic benefits of risk spreading and dry season income opportunities, the prices paid to smallholders must be stabilized at a fair level, otherwise a shift to other crops or practices might take place.

- [95] B Emana and H Storck. Improvement strategies for farming systems in the Eastern Highlands of Ethiopia. *Agricultural Economics*, 8(1):57–77, 1992.

KEY: EmanStor1992

ANNOTATION: Eleven distinct farming systems were distinguished, based on selected indicators and locations. The indicators involve the resource basis, cropping pattern and intensity, and the major activities including off-farm work. Statistical tests were used to verify the differences. Strategies are developed to improve their poor economic performance. A linear programming model is used to evaluate the effects on farm performance of reallocating the existing farm resources, and introduction of improved technologies. The type of relationship among the elements of the farming system determines the overall outcome of any improvement effort. Groundnut and livestock production are highly competitive. A package of technological innovations is needed to achieve a major improvement on the smallest farms.

- [96] R Emongor and J Kirsten. The impact of South African supermarkets on agricultural development in the SADC: a case study in Zambia, Namibia and Botswana. *Agrekon*, 48(1):60–84, March 2009.

KEY: EmonKirs2009

ANNOTATION: Supermarkets have expanded rapidly in SADC during the last decade, leading to fears that small-scale farmers and food processors could be excluded from access to urban markets. To assess the impact of supermarket chains on various participants in the supply chain, a survey was carried out in Botswana, Namibia and Zambia in 2004, 2005 and 2007. To determine the factors that influence the choice between the supermarket or traditional market channel and the impact of participation in the supermarket supply chain, a two-step treatment model was used. The results showed that over 80% of all processed food products in Botswana, Namibia and Zambia were imported from South Africa, and that supermarkets used a mixture of procurement systems for fresh fruit and vegetables and processed food products. Participation in the supermarkets channel had a positive impact on small-scale farmers' incomes. Farmers who supplied fresh fruit and vegetables to supermarkets had a significantly higher income than those who supplied to traditional markets in Zambia. The expansion of South African supermarkets into the SADC countries may be beneficial to small-scale farmers and therefore efforts should be made to incorporate them into the supermarkets' fresh fruit and vegetable supply chain.

- [97] D M Endale and G Fipps. Simulation-based irrigation scheduling as a water management tool in developing countries. *Irrigation and Drainage*, 50(3):249–257, September 2001.

KEY: EndeFipp2001

ANNOTATION: An Irrigation District Decision Support System (IRDDESS) is described and applied to a large irrigation scheme in the Middle Awash Valley of Ethiopia. Crop yields are simulated over a 12-year period in order to determine which of 12 separate irrigation schedules in use meet certain specified objectives. IRDDESS is a crop growth and irrigation district simulation model capable of predicting biomass development and yields for fields varying in soil type and irrigation management scenarios. IRDDESS also tracks water demand in the distribution system. Results show which of the 12 schedules will meet specific objectives of maximizing yields or minimizing water use and

illustrate the potential of such decision support system in evaluation and management of large irrigation schemes.

- [98] Robert E Evenson and Germano Mwabu. The effects of agricultural extension on farm yields in Kenya. Report 798, Economic Growth Center, Yale University, P.O. Box 208269, New Haven, Connecticut 06520-8269, September 1998.
KEY: EvenMwab1998

ANNOTATION: The paper examines effects of agricultural extension on crop yields in Kenya controlling for other determinants of yields, notably the schooling of farmers and agro-ecological characteristics of arable land. The data we use were collected by the Government of Kenya in 1982 and 1990, but the estimation results reported in the paper are based primarily on the 1982 data set. The sample used for estimation contains information about crop production, agricultural extension workers (exogenously supplied to farms), educational attainment of farmers, usage of farm inputs, among others. A quantile regression technique was used to investigate productivity effects of agricultural extension and other farm inputs over the entire conditional distribution of farm yield residuals. We find that productivity effect of agricultural extension is highest at the extreme ends of distribution of yield residuals. Complementarity of unobserved farmer ability with extension service at higher yield residuals and the diminishing returns to the extension input, which are uncompensated for by ability at the lower tail of the distribution, are hypothesized to account for this U-shaped pattern of the productivity effect of extension across yield quantiles. This finding suggests that for a given level of extension input, unobserved factors such as farm management abilities affect crop yields differently. Effects of schooling on farm yields are positive but statistically insignificant. Other determinants of farm yields that we analyze include labour input, farmer experience, agro-ecological characteristics of farms, fallow acreage, and types of crops grown.

- [99] Hamid H Faki, Yousif T Gumaa, and Mohamed A Ismail. Potential of the Sudan's irrigated sector in cereal grains production: Analysis of various policy options. *Agricultural Systems*, 48(4):457–483, 1995.

KEY: FakiEtAl1995

ANNOTATION: In this paper, a linear programming sector model was employed to analyze various policy options for exposing the potential of the Sudan's irrigated sector in enhancing grain production for improved food security, following a precarious contribution of rainfed production over the past decade. A free cropping pattern in irrigation schemes would be associated with large areas and production of grains under the existing financial cost and price levels, but would be bound with uncertainty of sustainable grain levels if prices change. Grain production targets could be imposed on irrigation schemes with manageable levels of support to producers and social costs. The main tools would be adequate input provision and adoption of improved production technology. The implementation would be favored by a structure of production in the irrigated sector that allows administrative control over production. This could be best blended with policy measures related to pricing and taxation levels of grain production. The comparative advantage of different schemes in producing certain crops should be utilized.

- [100] Salvatore Di Falco, Jean-Paul Chavas, and Melinda Smale. Farmer management of production risk on degraded lands: the role of wheat variety diversity in the Tigray region, Ethiopia. *Agricultural Economics*, 36(2):147–156, 2007.

KEY: FalcEtAl2007

ANNOTATION: This article investigates the effects of wheat genetic diversity and land degradation on risk and agricultural productivity in less favored production environments of a developing agricultural economy. Drawing production data from a household survey conducted in the highlands of Ethiopia, we estimate a stochastic production function to evaluate the effects of variety richness, land degradation, and their interaction on the mean and the variance of wheat yield. Ethiopia is a center of diversity for durum wheat and farmers manage complex variety mixtures on multiple plots. Econometric evidence shows that variety richness increases farm productivity. Variety richness also reduces yield variability but only for high levels of genetic diversity. Simulations with estimated parameters illustrate how planting more diverse durum wheat varieties on multiple plots contribute to improving farmer's welfare.

- [101] A E Faria and E Mubwandarikwa. The geometric combination of Bayesian forecasting models. *Journal of Forecasting*, 27(6):519–535, September 2008.

KEY: FariMubw2008

ANNOTATION: A nonlinear geometric combination of statistical models is proposed as an alternative approach to the usual linear combination or mixture. Contrary to the linear, the geometric model is closed under the regular exponential family of distributions, as we show. As a consequence, the distribution which results from the combination is unimodal and a single location parameter

can be chosen for decision making. In the case of Student t-distributions (of particular interest in forecasting) the geometric combination can be unimodal under a sufficient condition we have established. A comparative analysis between the geometric and linear combinations of predictive distributions from three Bayesian regression dynamic linear models, in a case of beer sales forecasting in Zimbabwe, shows the geometric model to consistently outperform its linear counterpart as well as its component models.

- [102] E L Ferguson, N Darmon, A Briend, and I M Premachandra. Food-based dietary guidelines can be developed and tested using linear programming analysis. *Journal of Nutrition*, 134(4):951–957, 2004.

KEY: FergEtAl2004

ANNOTATION: Effective food-based dietary guidelines (FBDGs) are required to combat micronutrient deficiencies. This study aimed to develop a rigorous approach for designing population-specific FBDGs. A 4-phase approach based on linear programming analysis was used to design, test, and refine the FBDGs. This was illustrated for Malawian children. In phase I, the objective function minimized the difference in the energy contributed by different food groups between modeled and observed diets for 16 observed diet types, while preferentially selecting foods most often consumed. Constraints ensured nutrient adequacy and diet palatability. In phase II, the meal/snack patterns of the phase I modeled diets were examined to develop season-specific FBDGs. In phase III, the robustness of these FBDGs, for ensuring a nutritionally adequate diet, was tested. The objective function, in this analysis, minimized selected nutrient levels in the modeled diets (i.e. chose the “worst-case scenario”), while respecting the FBDGs, palatability, and energy constraints. The FBDGs were refined in phase IV. In the Malawian example used to illustrate our approach, the FBDGs promoted daily consumption of maize flour, small dry fish (20 g), leaf relish, and 2-3 snacks. The last mentioned included mangoes, in the food-shortage season, and pumpkin in the food-plenty season. In addition, legume relish was recommended in the food-shortage season. The approach presented here can be used to design and then test the robustness of FBDGs for meeting nutrient recommendations.

- [103] Khaulani Fichani and Walter C Labys. Planning the future of Botswana’s coal. *International Journal of Global Energy Issues*, 25(1–2):60–82, 2006.

KEY: FichLaby2006

ANNOTATION: Botswana has vast proven deposits of steam coal, which, for a long time, the government has wanted to develop but without much success. The main objectives of this study are: to forecast possible coal exports from Botswana and the land routes for these exports; to determine the competitiveness of Botswana’s coal in world steam coal trade; to make recommendations on the appropriate policy for the exploitation of this coal. To accomplish these objectives, we construct a model of the global steam coal trade and apply this model to forecast the likely optimal size of mine, timing of capacity, and choice of export port for the years 2005 and 2010 from a 2000 base forecast year. The results of our regional analysis suggest that Botswana’s coal exports are competitive in Asia and Western Europe. These results are shown to be least sensitive to changes in rail transportation costs and marginal supply costs but more sensitive to changes in capital costs for mine development.

- [104] D Fields and T J Kim. Application of a computer-aided expert decision support system to rural-development in Kenya. *Computers Environment and Urban Systems*, 16(5):415–433, September-October 1992.

KEY: FielKim1992

ANNOTATION: This paper describes the utility of a computer-aided system that couples an expert system with other planning modeling techniques and hypermedia as a method to support institutional development. Using an example of rural development in Kenya, the paper describes the application of a computer-aided expert decision support system to aid local planners and administrators plan for investment in infrastructure to selected rural service centers.

- [105] G W Fischer and J Antoine. Agro-ecological land resources assessment for agricultural development planning. a case study of Kenya. making land use choices for district planning. Technical report, Land and Water Development Division Food and Agriculture Organization of the United Nations and International Institute for Applied Systems Analysis Rome, Rome, 1994.

KEY: FiscAnto1994

ANNOTATION: The potential for sustainable food production, including meat and milk, is determined by physical factors, primarily by soil and climatic conditions, and a complex interaction of socioeconomic, cultural and technological factors, such as farm sizes, level of farming and livestock inputs, management practices including soil conservation and enhancement, veterinary services, economic factors like market prices and access, credit availability, education and extension services.

At any given point in time, there are limits to the sustainable levels of food crop and livestock feed production obtainable from any given land area, and hence limits to the human and livestock population that can be supported from any area. Development of land resources to meet food needs of growing populations should be based on integral assessment and consideration of ecological, social and economic factors. Development policies in the past, while focusing on economic and social considerations, have largely ignored the ecological issues. Recognizing the critical importance of resource literacy, the Food and Agriculture Organization of the United Nations (FAO), with the collaboration of the International Institute for Applied Systems Analysis (IIASA), developed a land resources data base and a methodological framework to assess food production and population supporting potentials in developing countries,

- [106] Monica Fisher, Moushumi Chaudhury, and Brent McCusker. Do forests help rural households adapt to climate variability? evidence from Southern Malawi. *World Development*, 38(9):1241–1250, 2010.

KEY: FishEtAl2010

ANNOTATION: Summary Data from rural Malawi are used to assess the role of forests in rural household adaptation to climate variability, and to examine implications for adaptation to future climate change. Although forests do not currently play a role in anticipatory adaptation by rural households, they do appear important for reactive coping: providing food during shortages, and a source of cash for coping with weather-related crop failure. We find households most reliant on forests have low income per person, are located close to forest, and are headed by individuals who are older, more risk averse, and less educated than their cohorts.

- [107] N Fivaz, J R Cutland, and C J Balchin. Allocation and control of the truck fleet at Nchanga open-pit, Zambia. *Transactions of the Institution of Mining and Metallurgy, Section A: Mining Technology*, 82(803):a131–a139, 1973.

KEY: FivaEtAl1973

ANNOTATION: The Nchanga open-pit uses a mixed fleet of 12 electric powered shovels and 120 rear-dump trucks for the excavation of ore and overburden. A description is given of some recent work which resulted in the development and use of two manual control systems. The operations within each shift were controlled by the allocation of trucks to a shovel or group of shovels according to some ‘best’ solution and by comparing the achieved shovel production with its target production. The target for the ‘best’ allocation of trucks is obtained by use of a dynamic programming formulation of the truck-shovel problem. The shift performance is measured by two criteria: a production total (or tally) and a productivity index. The productivity index is a means of relating the production tally to the production capacity of the available fleet. The use of the productivity index is reinforcement to the control of the within-shift operations, so, in this sense, a two-level control system has been devised.

- [108] Steffen Flessa. The costs of hospital services: a case study of Evangelical Lutheran church hospitals in Tanzania. *Health Policy and Planning*, 13:397–407, 1998.

KEY: Fles1998

ANNOTATION: The health care systems of many developing countries are facing a severe crisis. Problems of financing services leads to high patient fees which make institutions of Western health care unaffordable for the majority of the rural poor. The conflict between sustainability and affordability of the official health care system challenges both local decision-makers and health management consultants. Decisions must be made soon so that the existing health care systems can survive. However, these decisions must be based on sound data, especially on the costs of health care services. The existing accounting systems of most hospitals in developing countries do not provide decision-makers with these data. Costs are generally underestimated. The leadership of the 16 hospitals of the Evangelical Lutheran Church in Tanzania is currently analyzing how the existing health care services should be restructured. Therefore, reliable estimates of the costs of hospitals services are required. A survey on ‘Costing of health services of the Evang. Luth. Church in Tanzania’ was prepared, which summarizes the results of seven months of field investigations in Lutheran hospitals. The major findings are that the costs of providing adequate services are much higher than expected. The most important factors determining these costs are the administrative efficiency of the hospital and the scope of services offered. The paper closes with some recommendations on how to improve the services in order to make them both affordable for the rural poor and financially sustainable for the Church. It is concluded that even the best improvement of technical efficiency will not safeguard the survival of the hospital-based health care services of the Lutheran Church in Tanzania. These findings call for a reallocation of health care resources to lower levels of the health care pyramid.

- [109] Steffen Flessa. Decision support for malaria-control programmes: A system dynamics model. *Health Care Management Science*, 2:181–191, 1999.
KEY: Fles1999
ANNOTATION: Although malaria claims millions of casualties every year there are hardly any recent efforts to model its epidemiology in order to support decision-makers of malaria-control programmes. There have been ample attempts to develop analytical models during the era of WHO malaria eradication programmes (1950–1970), but none of them was detailed enough to honour the high complexity arising from the interdependencies of the environment, the parasite, vector and host system. This paper presents a multi-group system dynamics model of the spread of malaria in an African country. Epidemiological details are included so that the impact of several intervention programmes can be simulated and analysed. The model's basic structure is fully described and some examples of the simulations are presented. It becomes obvious that detailed multi-group system dynamics models are valuable to assess the effectiveness and efficiency of anti-malaria campaigns.
- [110] Steffen Flessa. MOSHI: a culture-tailored management game for African hospital managers. *Tropical Doctor*, 31(3):144–146, July 2001.
KEY: Fles2001
ANNOTATION: The computer-based management game MOSHI (management of small hospitals) was developed in Tanzania and became an integrated component of a training programme for East African hospital managers. Players are in charge of a 120-bed hospital in rural Tanzania and have to make strategic and tactical decisions according to their own traditions and values. Thus, it becomes possible that the cultural gap between western management philosophy and traditional African values is bridged.
- [111] Steffen Flessa. Decision support for AIDS control programmes in eastern Africa. *OR Spectrum*, 25(2):265–291, May 2003.
KEY: Fles2003a
ANNOTATION: The Acquired Immune Deficiency Syndrome (AIDS) constitutes the worst hazard to health care systems in Eastern Africa. Misallocation of scarce resources of AIDS Control Programmes will unavoidably lead to additional infections and casualties. The following paper discusses a system dynamics model which allows to assess the impact of different interventions on a pattern population in Eastern Africa. It becomes obvious that short- and long-term consequences of these programmes differ significantly. The optimal allocation of resources, therefore, is highly complex and calls for decision support systems to sustain AIDS control programmes.
- [112] Steffen Flessa. Priorities and allocation of health care resources in developing countries: A case-study from the Mtwara region, Tanzania. *European Journal of Operational Research*, 150(1):67–80, October 2003.
KEY: Fles2003b
ANNOTATION: Models of health economics usually maximise the sum of individual health. However, as the term health reflects very different aspects of well being, quite different objectives can be derived for the allocation of health care resources. This paper analyses the optimum allocation of health care resources in the Mtwara region, Tanzania, for five different objectives: minimisation of death cases, minimisation of years of life lost, minimisation of incidence, minimisation of prevalence and minimisation of loss of quality of life. For this purpose a linear programme is developed. The different objective functions lead to completely different proposals of how to allocate health care resources. Therefore, the results of this paper call for a new discussion of health care priorities in developing countries.
- [113] A M Foltz. Modeling technology transfer in health information systems. Learning from the experience of Chad. *International Journal of Technology Assessment in Health Care*, 9(3):346–359, 1993.
KEY: Folt1993
ANNOTATION: Health information systems are complex combinations of methods of organization and computer technologies. They are idiosyncratic to each country. Chad's design of a national information system followed a process that can serve as a model for sustainable technology transfer—using consensual decision making and reinforcing administrative reforms while providing strong Ministry leadership and using technical assistance.
- [114] Augustin Kwasi Fosu. Does inequality constrain poverty reduction programs? evidence from Africa. *Journal of Policy Modeling*, 32(6):818–827, 2010.
KEY: Fosu2010818
ANNOTATION: Examined in the present study is the extent to which inequality influences the effectiveness of income growth in poverty reduction, based on 1990s data for a sample of African

economies. An analysis-of-covariance model is derived and estimated, with the headcount, gap, and squared gap poverty ratios serving as the respective dependent variables, and the Gini coefficient and PPP-adjusted income as explanatory variables. The study finds that the responsiveness of poverty to income is a decreasing function of inequality. The results imply a large variation across African countries in the amount of growth required to meet a unit of poverty reduction, as in the case of the MDG1, depending on the level of inequality. For efficient policymaking, therefore, a country-specific strategy with varying emphases on inequality relative to growth is warranted.

- [115] P Fox, J Rockström, and J Barron. Risk analysis and economic viability of water harvesting for supplemental irrigation in semi-arid Burkina Faso and Kenya. *Agricultural Systems*, 83(3):231–250, March 2005.

KEY: FoxEtAl2005

ANNOTATION: Food insecurity affects a large portion of the population in sub-Saharan Africa (SSA). To meet future food requirements current rainfed farming systems need to upgrade yield output. One way is to improve water and fertiliser management in crop production. But adaptation among farmers will depend on perceived risk reduction of harvest failure as well as economic benefit for the household. Here, we present risk analysis and economical benefit estimates of a water harvesting (WH) system for supplemental irrigation (SI). Focus of the analysis is on reducing investment risk to improve self-sufficiency in staple food production. The analysis is based on data from two on-farm experimental sites with SI for cereals in currently practised smallholder farming system in semi-arid Burkina Faso and Kenya, respectively. The WH system enables for both SI of staple crop (sorghum and maize) and a fully irrigated off-season cash crop (tomatoes). Different investment scenarios are presented in a matrix of four reservoir sealants combined with three labour opportunity costs. It is shown that the WH system is labour intensive but risk-reducing investment at the two locations. The current cultivation practices do not attain food self-sufficiency in farm households. WH with SI resulted in a net profit of 151626 USD year⁻¹ ha⁻¹ for the Burkina case and 109477 USD year⁻¹ ha⁻¹ for the Kenya case depending on labour opportunity cost, compared to -83 to 15 USD year⁻¹ ha⁻¹ for the Burkina case and 40130 USD year⁻¹ ha⁻¹ for the Kenyan case for current farming practices. Opportunity cost represents 066% of the investment cost in an SI system depending on type of sealant. The most economical strategy under local labour conditions was obtained using thin plastic sheeting as reservoir sealant. This resulted in a net profit of 390 and 73 USD year⁻¹ ha⁻¹ for the Burkina Faso and Kenyan respective site after household consumption was deducted. The analysis suggests a strong mutual dependence between investment in WH for SI and input of fertiliser. The WH system is only economically viable if combined with improved soil fertility management, but the investment in fertiliser inputs may only be viable in the long term when combined with SI.

- [116] Gian Nicola Francesconi, Nico Heerink, and Marijke D’Haese. Evolution and challenges of dairy supply chains: Evidence from supermarkets, industries and consumers in Ethiopia. *Food Policy*, 35(1):60 – 68, 2010.

KEY: FranEtAl2010

ANNOTATION: In developing countries the demand for products of animal origin is expected to grow rapidly in the coming years. Using data collected from 200 urban households this study examines the evolution of the dairy market in Ethiopia. In particular, this study suggests that although the Ethiopian dairy market remains extremely thin and volatile, the commercialization of processed dairy products through supermarkets is expanding and is expected to keep doing so in the foreseeable future. Increasing urbanization and corresponding changes in consumer preferences, behaviour and purchasing power are the identified causes for the rise of supermarket-processor dairy chains. This study shows also that emerging dairy chains provide new market opportunities to Ethiopian farmers, but the existence of retail-industrial monopolies and monopsonies jeopardize farmers’ economic benefits to a great extent. The study concludes with some implications for policy and further research.

- [117] Steven Franzel. *Valuing Agroforestry Systems: Methods and Applications*, chapter : Financial analysis of agroforestry practices: Fodder shrubs in Kenya, woodlots in Tanzania, and improved fallows in Zambia, pages 9–37. Number 2 in *Advances in Agroforestry*. Kluwer, 2004.

KEY: Fran2004

- [118] Emmanuel Gabreyohannes. A nonlinear approach to modelling the residential electricity consumption in Ethiopia. *Energy Economics*, 32(3):515 – 523, 2010.

KEY: Gabr2010

ANNOTATION: In this paper an attempt is made to model, analyze and forecast the residential electricity consumption in Ethiopia using the self-exciting threshold autoregressive (SETAR) model and the smooth transition regression (STR) model. For comparison purposes, the application

was also extended to standard linear models. During the empirical presentation of both models, significant nonlinear effects were found and linearity was rejected. The SETAR model was found out to be relatively better than the linear autoregressive model in out-of-sample point and interval (density) forecasts. Results from our STR model showed that the residual variance of the fitted STR model was only about 65.7% of that of the linear ARX model. Thus, we can conclude that the inclusion of the nonlinear part, which basically accounts for the arrival of extreme price events, leads to improvements in the explanatory abilities of the model for electricity consumption in Ethiopia.

- [119] Takele Gadissa and Desalegn Chemed. Effects of drip irrigation levels and planting methods on yield and yield components of green pepper (*capsicum annum, l.*) in Bako, Ethiopia. *Agricultural Water Management*, 96(11):1673–1678, 2009.

KEY: GadiChem2009

ANNOTATION: A field experiment was conducted to investigate the effects of different levels of drip irrigation and planting methods on yield and yield components (number of fruits per plant, number of primary and secondary branches per plant, and plant height) of green pepper (*Capsicum annum, L.*) in Bako, Ethiopia. Three irrigation levels (50, 75 and 100% of ETc) and two planting methods (normal and paired-row planting) were applied. The experiment was laid out in a split plot design, with irrigation levels as main plots and planting methods as sub-plots, in three replications. It was found that the effects of both treatments on yield, number of fruits per plant and plant height of green pepper were highly significant ($p < 0.01$) whereas the number of primary and secondary branches per plant was affected significantly ($p < 0.05$). The maximum and minimum values of the yield and yield components were recorded from treatment plots I100P (full irrigation level with paired-row planting method) and I50P (50% of ETc irrigation level with paired-row planting method), respectively, with the exception of plant height. However, the average plant height (cm) recorded from the I100N treatment plot was not significantly different from the I100P treatment plot. Moreover, it was found that the effect of treatment interactions on both yield and yield components of green pepper was found to be highly significant ($p < 0.01$). A 50% reduction in irrigation level caused a reduction in yield of about 48.3 and 74.4% under the normal and paired-row planting methods, respectively, whereas, a 25% reduction in irrigation level caused a reduction in yield of about 22.8 and 47.7% under the same planting methods. Under both deficit irrigation levels (I50 and I75), the normal planting method gave higher total yield and yield components of green pepper than the paired-row planting method. Yield response factor (ky) values of 0.96 and 1.57 were determined for the normal and paired-row planting methods, respectively, suggesting utmost precautions when using the paired-row planting in areas with limited water supply. The results revealed that full irrigation water supply under paired-row planting method (I100P) could be used for the production of green pepper in an area with no water shortage. Moreover, it was found that the average yields recorded from the I75 under the paired-row planting method is fairly greater than the national average.

- [120] K A Galvin, P K Thornton, J R de Pinho, J Sunderland, and R B Boone. Integrated modeling and its potential for resolving conflicts between conservation and people in the rangelands of East Africa. *Human Ecology*, 34:155–183, 2006.

KEY: GalvEtAl2006

ANNOTATION: A major challenge for contemporary conservation policies and practices is formulating workable compromises between wildlife conservation and the people who live with wildlife. We strongly support the view that anthropology has a critical role to play in contributing to our understanding of human-environment interactions. The study of complex biophysical and human systems can be greatly assisted by appropriate simulation models that integrate what is known about ecological and human decision-making processes. We have developed an integrated modeling system for assessing scenarios in the Ngorongoro Conservation Area in northern Tanzania to modify the situation there to improve human welfare without compromising conservation value. We present the results of some scenarios that indicate that the current situation there is not sustainable, and that tough policy decisions need to be taken if household well-being of the pastoralists who live there is to be improved or even sustained.

- [121] Pierre J Gerber, Gerrit J Carsjens, Thaneek Pak-uthai, and Timothy P Robinson. Decision support for spatially targeted livestock policies: Diverse examples from Uganda and Thailand. *Agricultural Systems*, 96(1-3):37–51, March 2008.

KEY: GerbEtAl2008

ANNOTATION: Public policies are needed to guide livestock sector's changes along a path that is

sustainable in economic, social and environmental terms. These policies should include multiple development objectives and be adapted to location-specific contexts. Policy makers need assistance in dealing with such complex decisions. Spatial information can be integrated in decision support tools to support policy making, and is becoming increasingly available in the developing world. Spatial information, however, has seldom been used in livestock sector policy formulation because policy makers generally do not have access to resources for spatial modelling. The objective of this paper is to bridge this gap by proposing an approach to consolidating and analysing spatial information in the context of limited modelling resources. Rooted in practical experience, a method is proposed that combines two multiple criteria decision-making techniques (weighted linear combination and analytical hierarchical processes), parameterised in a participatory process and implemented in a GIS. The method is tested in two different contexts: support to single objective decision-making for targeting trypanosomiasis control interventions in Uganda, and support to multiple objective decision-making for spatial planning of livestock production development in Thailand. The results show the advantages of such an approach, in terms of stakeholder involvement and practical application to support decision-making, but also highlight two shortcomings: dependence on high quality data and uncertainty with regard to the decision rule. While the former will be addressed as digital information becomes increasingly available, the latter, embedded in any decision-making process, calls for thorough sensitivity analyses and careful scrutiny of results.

- [122] Kindie Getnet, Ethiopia Ambo, Wim Verbeke, and Jacques Viaene. Modeling spatial price transmission in the grain markets of Ethiopia with an application of ARDL (autoregressive distributed lag) approach to white teff. *Agricultural Economics*, 33(s3):491–502, November 2005.

KEY: GetnEtAl2005

ANNOTATION: Following the agricultural market liberalization policy, there is an emerging grain market structure in Ethiopia in which the central wholesale market exhibits concentration of power and spatial integration with the local markets. Due to this, it is hypothesized that the central wholesale market influences the long-run price movements in the local markets. The relationship can be modeled as spatial price equilibrium with the aim to guide subsequent policy decisions with regard to public intervention in the post-liberalization period. In this study, we modeled the spatial equilibrium relationship between the producer and the wholesale prices of white teff, a major staple in Ethiopia, using the autoregressive distributed lag modeling approach to cointegration analysis. First, the existence of a nonspurious long-run relationship in levels between the producer prices in the local market and the wholesale prices in the central market is confirmed. Second, the long-run relationship and the error correction model for the producer price are estimated. The results reveal that the wholesale price of white teff in the central consumer market is a major short- and long-run determinant of the producer price in the local supply markets. Therefore, the institutional role of the government with the aim of improving producers' marketing margin and the overall performance of the grain markets in the post-liberalization period can be influenced through targeted interventions at the central wholesale market.

- [123] C C Gibson and S A Marks. Transforming rural hunters into conservationists: an assessment of community-based wildlife management programs in Africa. *World Development*, 23:941–957, 1995.

KEY: GibsMark1995

ANNOTATION: The failure of conventional wildlife management in Eastern and Southern Africa has led several countries to implement community-based wildlife programs. This paper examines the assumptions these initiatives make about rural hunters, and describe how the program attempt to induce individuals away from illegal hunting. Using game theory and a case study from Zambia, it finds that these programs misunderstand some of the economic, political and social benefits of local hunting. As a result, community-based wildlife management schemes succeed in protecting some of the larger mammals only by virtue of their increased enforcement levels, not their ability to distribute socioeconomic benefits. Rather than support conservation, local hunters continue to kill game at a rate comparable to the days before the programs, although they have shifted their tactics and prey selection.

- [124] Lena Giesbert, Susan Steiner, and Mirko Bendig. Participation in micro life insurance and the use of other financial services in Ghana. *Journal of Risk and Insurance*, 2011. publisher: Blackwell Publishing Inc; ISSN: 1539-6975; also available as: [//dx.doi.org/10.1111/j.1539-6975.2010.01405.x](http://dx.doi.org/10.1111/j.1539-6975.2010.01405.x).

KEY: GiesEtAl2011

ANNOTATION: Abstract This article investigates households decisions to take up micro life insurance and to use other financial services. It estimates a multivariate probit model based on Ghanaian household survey data. The results suggest a mutually reinforcing relationship between the use of

insurance and the use of other formal financial services. Risk-averse households and households who consider themselves more exposed to risk than others are found to be less likely to participate in insurance. This suggests that insurance is considered to be risky. There is indicative evidence for adverse selection and a life-cycle effect in the uptake of insurance.

- [125] Joyce Wangui Gikandi and Chris Bloor. Adoption and effectiveness of electronic banking in Kenya. *Electronic Commerce Research and Applications*, 9(4):277–282, 2010.

KEY: GikaBloo2009

ANNOTATION: A global explosion in the use of electronic commerce has been witnessed in recent times with the monetary value of products and services exchanged electronically being estimated at above US\$ 7 trillion in the year 2004. Research has followed the same pattern especially in investigating factors influencing the adoption and effectiveness of e-commerce in retail businesses. However, little has been done to establish these factors in electronic banking (e-banking) in developing countries. The aim of this research was to investigate the factors influencing the adoption and effectiveness of e-banking in retail banking. Initial and follow-up surveys were carried out in the years 2005 and 2009, respectively, which involved banks controlling approximately 90% of formal retail banking in Kenya. The follow-up survey was meant to monitor trends between the periods of the two surveys. Results varied across the period.

- [126] Asmerom M Gilau and Mitchell J Small. Designing cost-effective seawater reverse osmosis system under optimal energy options. *Renewable Energy*, 33(4):617 – 630, 2008.

KEY: GilaSmal2008

ANNOTATION: Today, three billion people around the world have no access to clean drinking water and about 1.76 billion people live in areas already facing a high degree of water stress. This paper analyzes the cost-effectiveness of a stand alone small-scale renewable energy-powered seawater reverse osmosis (SWRO) system for developing countries. In this paper, we have introduced a new methodology; an energy optimization model which simulates hourly power production from renewable energy sources. Applying the model using the wind and solar radiation conditions for Eritrea, East Africa, we have computed hourly water production for a two-stage SWRO system with a capacity of 35 m^3 /day. According to our results, specific energy consumption is about 2.33 kW h/ m^3 , which is a lower value than that achieved in most of the previous designs. The use of a booster pump, energy recovery turbine and an appropriate membrane, allows the specific energy consumption to be decreased by about 70% compared to less efficient design without these features. The energy recovery turbine results in a reduction in the water cost of about 41%. Our results show that a wind-powered system is the least cost and a PV-powered system the most expensive, with finished water costs of about 0.50 and 1.00\$/ m^3 , respectively. By international standards, for example, in China, these values are considered economically feasible. Detailed simulations of the RO system design, energy options, and power, water, and life-cycle costs are presented.

- [127] Solomon Gizaw, Hans Komen, and Johan A M van Arendonk. Optimal village breeding schemes under smallholder sheep farming systems. *Livestock Science*, 124(1-3):82–88, September 2009.

KEY: GizaEtAl2009

ANNOTATION: Despite challenges in the implementation of livestock genetic improvement programs in developing regions, including centralized nucleus breeding schemes, these programs can contribute to the improvement of the livelihood of smallholder farmers. In this paper, we present a community- or village-based breeding scheme in which breeding activities are carried out by communities of smallholder farmers. We evaluated genetic responses and the rate of inbreeding from alternative village sheep breeding schemes that were based on a survey of existing flock structure and breeding management in a sheep-barley system in Ethiopia. This survey showed that individual flock sizes were small, and that the majority of farmers practiced mixed grazing and uncontrolled mating of their flocks in communal grazing lands within villages. Here we evaluated within-village schemes (selection across flocks within a village) and across-village schemes (selection across villages) at different intensities of ram selection (i.e. proportions of rams selected, P). Our results showed that under within-village schemes, intensity of selection could not be increased (i.e. P could not be decreased below 0.149) when the rate of inbreeding was constrained to an acceptable level of 0.01, resulting in low genetic gain. The most optimal scheme was found to be across-village selection with at least three villages cooperating and P=0.05. Our results also indicated that genetic gain from village breeding schemes with mass selection and BLUP selection is comparable. Village breeding schemes can make a significant contribution to the genetic improvement of livestock in Ethiopia and other developing countries.

- [128] C H Gladwin, A M Thomson, J S Peterson, and A S Anderson. Addressing food security in Africa via multiple livelihood strategies of women farmers. *Food Policy*, 26(2):177–207, 2001.
KEY: GladEtAl2001
ANNOTATION: Because food insecurity is primarily a problem of low household incomes and poverty, and not just inadequate food production, projects and programs for food insecure African farmers which aim at increasing production of subsistence crops may be ineffective. Instead, government should look for ways to improve returns to farmers' resources in a broader context, which may include expanded opportunities for non-farm microenterprises and agricultural labor. This has been the conventional wisdom since the writings of Amartya Sen. Still unclear, however, are the implications of his thinking for the roles of African women farmers who are traditionally the food-crop producers in Africa and are often food insecure. Immediate expansion of income-earning activities such as cash cropping and non-farm microenterprises may not be possible for women in male headed households in many African societies where cash income is seen as part of the male domain. In addition, women farmers may need a long adjustment period to diversify their income sources fully because most African countries are at the early stages of structural transformation. Different developmental interventions, both in policy and in technology, are therefore needed to address food security and economic transformations in Africa in the short and long term.
- [129] Reginald Herbold Green and Hans Singer. Sub-Saharan Africa in depression: The impact on the welfare of children. *World Development*, 12(3):283–295, March 1984.
KEY: GreeSing1984
ANNOTATION: This paper analyses the impact of the economic crisis on the welfare of children in Sub-Saharan Africa, an area which includes most of the least developed and most severely affected countries. These countries are characterized by: low levels of skilled person-power, dependency on their primary product exports, small industrial sectors, a lagging food production growth, a high proportion of rural population and a child dependency ratio that is virtually 1 to 1. The situations of Nigeria, Zambia and Tanzania are examined in detail. In Zambia where there is substantial evidence of worsening of the condition of children in the 1970s, the most urgent requirement is additional resources, particularly foreign exchange. Such is also the case with Tanzania, while Nigeria does have the resources to develop a more coherent economy and finance basic services adequately.
- [130] Giorgio Guariso and Dale Whittington. Implications of Ethiopian water development for Egypt and Sudan. *International Journal of Water Resources Development*, 3(2):105–114, 1987.
KEY: GuarWhit1987
ANNOTATION: This paper examines the implications for Egypt and Sudan of the development of Blue Nile water resources by Ethiopia. The long-term development program produced between 1958 and 1963 by the Ethiopian government in collaboration with the US Bureau of Reclamation is summarized. A linear programming model is used to examine the effects on Egypt and Sudan of implementing this program. It is found that water for agricultural use in Egypt and Sudan would actually increase, though there would be some adverse consequences for Egypt.
- [131] Bekithemba Gumbo, Siphon Mlilo, Jeff Broome, and Darren Lumbroso. Industrial water demand management and cleaner production potential: a case of three industries in Bulawayo, Zimbabwe. *Physics and Chemistry of the Earth, Parts A/B/C*, 28(20-27):797 – 804, 2003.
KEY: GumbEtAl2003
ANNOTATION: The combination of water demand management and cleaner production concepts have resulted in both economical and ecological benefits. The biggest challenge for developing countries is how to retrofit the industrial processes, which at times are based on obsolete technology, within financial, institutional and legal constraints. Processes in closed circuits can reduce water intake substantially and minimise resource input and the subsequent waste thereby reducing pollution of finite fresh water resources. Three industries were studied in Bulawayo, Zimbabwe to identify potential opportunities for reducing water intake and material usage and minimising waste. The industries comprised of a wire galvanising company, soft drink manufacturing and sugar refining industry. The results show that the wire galvanising industry could save up to 17% of water by recycling hot quench water through a cooling system. The industry can eliminate by substitution the use of toxic materials, namely lead and ammonium chloride and reduce the use of hydrochloric acid by half through using an induction heating chamber instead of lead during the annealing step. For the soft drink manufacturing industry water intake could be reduced by 5% through recycling filter-backwash water via the water treatment plant. Use of the pig system could save approximately 12 m³/month of syrup and help reduce trade effluent fees by Z\$30/m³

of 'soft drink'. Use of a heat exchanger system in the sugar refining industry can reduce water intake by approximately $57 \text{ m}^3/100\text{t}$ 'raw sugar' effluent volume by about $28 \text{ m}^3/100\text{t}$ 'raw sugar'. The water charges would effectively be reduced by 52% and trade effluent fees by Z\$3384/100 t 'raw sugar' (57%). Proper equipment selection, equipment modification and good house-keeping procedures could further help industries reduce water intake and minimise waste.

- [132] T Habtemariam, R Howitt, R Ruppanner, and H P Riemann. Application of a linear-programming model to the control of African trypanosomiasis. *Preventive Veterinary Medicine*, 3(1):1–14, 1984.

KEY: HabtEtAl1984

- [133] S Haddad and P Fournier. Quality, cost and utilization of health-services in developing-countries - a longitudinal-study in Zaire. *Social Science & Medicine*, 40(6):743–753, March 1995.

KEY: HaddFour1995

ANNOTATION: Many developing countries, particularly in Africa, have recently introduced payment schemes based on the selling of essential drugs. This is one of the main elements of the Bamako Initiative according to which the income generated would ensure a reliable supply of drugs and would improve other aspects of the quality of the services offered. Thus, quality improvements would compensate for the financial barrier and as a result the utilization of public health services would be increased or at least maintained. These hypotheses have proven to be partially valid, since there have been cases where the utilization of health services has increased and others where it has decreased; these inconclusive results have fuelled criticisms concerning the inequitable nature of these measures. This longitudinal study in a rural community of Zaire shows that the utilization of health services had diminished by close to 40% over 5 yr (1987-1991) and that 18-32% of this decrease is explained by cost. The regular supply of drugs and the improvement in the technical quality of the services-technical qualification of the staff, allocation of microscopes, and renovation of the infrastructures-was not enough to compensate for the additional financial barriers created by the increased cost of services. However, on a local level, the interpersonal qualities displayed by some of the nurses sometimes helped to compensate for the negative effects of the costs, and even to increase the level of utilization of some health centres. The quality of public services has often been neglected in developing countries. While some attention is given to technical qualities, the interpersonal components of the quality of the services are generally ignored or underestimated by planners and they are the very components which are most resistant to change. It will be a major challenge for health systems to address this issue of quality of care in order to minimize the negative impact of the introduction of user payment schemes. Therefore, now is the time to place quality next to coverage in planners' agendas.

- [134] D C Hall, H M Kaiser, and R W Blake. Modelling the economics of animal health control programs using dynamic programming. *Agricultural Systems*, 56(1):125–144, 1998.

KEY: HallEtAl1998

ANNOTATION: A new application of an optimization tool, dynamic programming (DP), is described to model the economics of animal health control programs. To demonstrate the value of this technique, a model is applied to determine optimal net benefits of controlling East Coast fever (ECF) in Malawi Zebu cattle in the Lilongwe plateau. The objective function was the present value of net benefits due to treatment, defined as mortality savings minus treatment costs. Mortality savings were based on decreased mortality from ECF following treatment. Model constraints included herd size, animal (herd) nutritional requirements, and program budget. Treatment options were tank dipping in acaricide, and vaccination. Secondary data from a dipping trial of 1800 Malawi Zebu cattle conducted from 1991 to 1994 were used to determine probabilities of mortality. Total optimal net benefits of long-term treatment from vaccination (Malawi Kwacha (MK) 21 069) exceeded benefits for treatment with chlorfenvinphos acaricide (MK 15 203).

- [135] Francos Halla. A SWOT analysis of strategic urban development planning: The case of Dar es Salaam City in Tanzania. *Habitat International*, 31(1):130 – 142, 2007.

KEY: Hall2007

ANNOTATION: Preparation and implementation of urban general and detailed planning schemes, according to respective legislation, preoccupies most practitioners of the profession of urban and regional development planning and management worldwide. For a century lasting from 1850s to 1940s the professional practice was guided by the urban design paradigm, which embodies architectural concepts and principles of municipal engineering. For the following half a century lasting from late 1940s to early 1990s the professional practice was guided by the procedural or master-planning paradigm, which embodies the concepts of technocracy, bureaucracy, rigidity and comprehensiveness. Since 1990s, the professional practice has been guided by the political-economy

or urban management paradigm, which embodies participatory, transparency, flexibility and being strategic. Whereas urban design continues to be applied in preparation and implementation of urban detailed planning schemes at sub-city level, urban management has continued to replace the procedural or master planning approach in preparation and implementation of citywide general planning schemes. Strengths, weaknesses, opportunities and threats (SWOT) surrounding the procedural or master-planning approach have been widely but negatively analysed in the existing literature. Thus, in this paper a SWOT analysis is done regarding the urban management approach using the case of Dar es Salaam City in Tanzania. Participant observation and documentary reviews have been adopted in capturing and analysing the available data. Main findings lead to a conclusion that the urban management approach is stronger than the procedural or master-planning approach in planning and managing cities, generally, and planning and managing Dar es Salaam City, specifically.

- [136] Hamisai Hamandawana, Raban Chanda, and Frank Eckardt. Hypergame analysis and hydroconflicts in the Okavango drainage basin. *Water International*, 32(4):538–557, December 2007.

KEY: HamaEtAl2007

ANNOTATION: This article provides a game theory based approach to the analysis of interstate conflict between Angola, Botswana and Namibia over the Okavango River's shared water resources and tries to offer strategies that can be employed to harmonize incongruent interests. This is done by providing a compressed scenario in which interstate conflicts revolve around lack of adequate mechanisms to satisfactorily distribute shared water resources. The basic premise of the analysis is the following: if relevant data are available, the mathematical inclination of game theoretic modelling provides an objective framework for working out sharing arrangements that minimize conflict. We illustrate this claim on the basis of a hypothetical game where riparian states involved make compensatory sacrifices in order to offset the losses incurred by other partners. We cautiously provide suggestions for the way forward without pretending that these are exhaustive.

- [137] Joel Hartter and Kevin Boston. An integrated approach to modeling resource utilization for rural communities in developing countries. *Journal of Environmental Management*, 85(1):78 – 92, 2007.

KEY: HartBost2007

ANNOTATION: Resource consumption in developing countries has been the focus of a considerable amount of research. What has been understudied however, has been the feedback affects of resource consumption on resource availability to both households and communities. Heavy reliance on natural resources and intensive smallholder agriculture common to many rural communities in developing countries has forced people to fulfill short-term needs to the detriment of long-term ecological and livelihood sustainability. This paper introduces a conceptual framework to examine how individuals and households fulfill daily caloric needs and the aggregate effects on resource availability and consumption. Data were collected from a large number of published case studies of rural land-use dynamics, growth and yield models, and human livelihoods were reviewed from scientific journals, reports published by NGOs, and government reports. Using inputs defined by the user, the model tracks annual fuelwood and agricultural land use based on meeting individual energy demands. A case-study-based analysis was patterned after smallholder agriculturalists at the family and community level. Three scenarios are presented in this paper using data from Uganda to illustrate the application of this model.

- [138] F Hartwich and M von Oppen. Who contributes efficiently to development? Evaluating agricultural R & D in Cameroon and Tanzania. *Quarterly Journal of International Agriculture*, 45:47–70, 2006.

KEY: HartOppe2006

ANNOTATION: The article presents results from an evaluation of the technical efficiency of agricultural research and development (R& D) activities at universities and government research organizations in Cameroon and Tanzania. Data Envelopment Analysis is used to measure multiple-input multiple-output relations in the R& D process. The calculations are expanded with qualitative information about the relevance of R& D to its users applying the Analytic Hierarchy Process method in which peers rate the relevance of R& D outputs. The findings suggest that though the evaluated universities did not have a mandate for development-oriented R& D, they were as efficient in conducting agricultural R& D as national agricultural research organizations or international agricultural research centers. International research centers were found to generate relevant R& D outputs, but at high costs, particularly with regard to the international staff they use. The new process evaluation method tested in the study allows to compare the efficiency with which research entities operate in order to make better micro management decisions, e.g., whom to involve and

- whom to encourage to become more efficient. The method is complementary to economic impact assessment of agricultural R& D which is usually conducted at the more aggregated program level.
- [139] Rashid Hassan, Greg Hertzler, and James K A Benhin. Depletion of forest resources in Sudan: Intervention options for optimal control. *Energy Policy*, 37(4):1195 – 1203, 2009.
KEY: HassEtAl2009
ANNOTATION: Agricultural expansion and over-cutting of trees for fuelwood are important causes of deforestation in arid and semi-arid countries such as Sudan. The consequence is increased desertification and high erosion and loss of soil nutrients leading to declining agricultural productivity. However, the social costs of the deforestation externality are not taken into account in present forest management and land use planning in Sudan leading to under-pricing and over-exploitation of the country's forest resources. This study evaluated the suitability of approaches commonly used by most forest resource management agencies for prediction of the state and control of harvesting of forest resources against alternative empirical simulation models using relevant information about economic behaviour of trading agents in the fuelwood market. Results showed the clear superiority of models integrating market behaviour over current approaches in the ability to better simulate real trends of wood consumption and hence depletion rates. The study also adopted an optimal control model to derive socially optimal forest harvesting regimes. The results showed that current rates of forest resource rent recovery and reforestation efforts are very far from optimal. Results also suggest that, in addition to optimal pricing and higher reforestation efforts, promotion and availability of fuel substitutes and investment in wood energy conversion efficiencies have a strong potential for curbing the problem of deforestation in Sudan.
- [140] R E Hayes, J M Mwale, P Tembo, and J I Wadsworth. Computer-optimized weaning food blends. *Food and Nutrition Bulletin*, 16:245–262, 1995.
KEY: HayeEtAl1995
ANNOTATION: This computerized linear programming study was performed to formulate low-cost, commercially processed, blended weaning foods, and even less expensive, home-prepared, blended weaning foods, with excellent energy and protein value for use in areas of Lusaka, Zambia, where the risk of malnutrition is high.
- [141] A Hazlewood and I Livingstone. Irrigation economics in poor countries, illustrated by the Usangu plains of Tanzania. Technical report, Queen Elizabeth House, Oxford, U.K., 1982.
KEY: HazLivi1982
ANNOTATION: Considers that the development of irrigation in less developed countries needs to be appraised in the context of 'integrated rural development'. The calculation of irrigation potential is illustrated; and simple linear programming methods are demonstrated to determine the optimum farming pattern with limited water supplies. Water supply estimation is discussed in relation to farmers' attitudes to risk. A Tanzanian case study shows how productive potential may be calculated, and how the wider impact of irrigation on the local economy may be considered. Economies of scale versus small-scale irrigation schemes are considered, and the relationship between economic and technological choice in irrigation is reviewed.
- [142] John W Hearne. Formulating a water release policy for the Pongola floodplain: A simulation approach. *OR Letters*, pages 323–330, November 1991.
KEY: Hear1991
ANNOTATION: Floods have always played a role in the functioning of the traditional subsistence pastoral system on the Makatini Flats which surrounds the Pongola floodplain. This area lies just south of the Mozambique border in north-eastern South Africa. With the impoundment of the Pongola river upstream of this area the timing of the annual flood is now largely under the control of man and hence has become a management problem. To help resolve this problem a differential equation model of the pastoral system was developed. The model is used to assess the impact on the pastoral system of different times for the annual flood. A policy for the timing of the annual flood is then suggested.
- [143] Kurt Heidenberger and Steffen Flessa. A system dynamics model for AIDS policy support in Tanzania. *European Journal of Operational Research*, 70(2):167–176, October 1993.
KEY: HeidFles1993
ANNOTATION: The facts about AIDS in sub-Saharan Africa are not well known though about one third of all globally known AIDS cases is recorded in sub-Saharan Africa. In the so-called pattern 2 countries such as Congo, Rwanda, Tanzania, Uganda, Zaire or Zambia the HIV infection shows original traits which make it epidemiologically very different from HIV in the United States and Europe, the pattern 1 countries. Most of the policy oriented AIDS/HIV modelling efforts have

concentrated on pattern 1 countries. Yet Operational Research, with its client-oriented modelling philosophy can also offer assistance to AIDS policy makers in pattern 2 countries. Using the methods of system dynamics a detailed multi-group model of the spread of AIDS in the Tanzanian population has been developed. It is implemented on a personal computer and is capable of capturing complex virological and behavioral traits of the epidemic whilst illustrating the medical and some economic consequences in an easily conceivable graphical form. The model's basic structure is fully described and some examples of the results are presented.

- [144] M Herrero, E Gonzalez-Estrada, P K Thornton, C Quiros, M M Waithaka, R Ruiz, and G Hoogenboom. IMPACT: Generic household-level databases and diagnostics tools for integrated crop-livestock systems analysis. *Agricultural Systems*, 92(1–3):240–265, January 2007.
KEY: HerrEtA12007
ANNOTATION: We outline the need for generic crop-livestock systems databases and data standards for comprehensive systems analysis in developing countries. We also indicate the type of data that such databases should contain and review how they can be collected. We describe IMPACT, a database and analysis tool that we have developed that goes some way to meeting the demands that may be made of such systems data. Analysis tools, links to models and uses of such databases are briefly described and illustrated with case studies from Kenya, Ghana and Sri Lanka. The paper concludes with a discussion of the needs for a more coherent integration of global data collection and improved sharing of data for better articulation of research and development outcomes in developing countries.
- [145] J Heyer. A linear programming analysis of constraints on peasant farms in Kenya. *Food Research Institute Studies*, 10:55–67, 1971.
KEY: Heye1971
- [146] Stein T Holden. Peasant household modelling: farming systems evolution and sustainability in northern Zambia. *Agricultural Economics*, 9:241–267, 1993.
KEY: Hold1993a
ANNOTATION: Chitemene slash-and-burn cultivation continues to be a dominating cropping system in northern Zambia even after the introduction of modern technologies such as hybrid maize and fertilizer. The rationale of farming systems evolution in northern Zambia has been analyzed by goal programming based on the theories of Chayanov (1966) and Nakajima (1986). The major changes in agricultural technologies in northern Zambia during this century has been the introduction of cassava, maize and fertilizer technologies. Cassava has had the most significant impact. By switching from finger-millet to cassava as the main staple the peasants could reduce their total labour requirement to meet their basic food needs by as much as 40%. The rapid expansion of maize production in northern Zambia from the late 70s to the late 80s depended critically on the government policy of equity pricing and input subsidisation. The models predicted that the removal of fertilizer subsidies would result in a dramatic reduction in maize production.
- [147] Stein T Holden. The potential of agroforestry in the high rainfall areas of Zambia: a peasant programming model approach. *Agroforestry Systems*, 24(1):39–55, January 1993.
KEY: Hold1993b
ANNOTATION: Existing cropping systems in Northern Zambia cause deforestation and soil degradation. To reduce the environmental problems, the potential of alley cropping and pigeon peas replacing the existing cropping systems was analyzed by the use of multi-objective programming models of peasant households. The models were formulated based on the theories of Chayanov and Nakajima which are suitable under conditions of imperfect labour markets. Risk was incorporated in the models in relation to weather and fertilizer supply. The models provide an opportunity to relate key characteristics of new technologies to key characteristics of peasants' preferences and resource constraints. The models may also be used to identify minimum performance levels required for new technologies to be found acceptable.
- [148] O S Hopkins, D T Lauria, and A Kolb. Demand-based planning of rural water systems in developing countries. *Journal of Water Resources Planning and Management (ASCE)*, 130(1):44–52, January–February 2004.
KEY: HopkEtA12004
ANNOTATION: In the past decade, international donors and governments have generally required water supply systems to be financially self-sufficient, with stakeholder participation in their planning and operation to ensure sustainability. Efforts are being made to shift planning from a process that tends to be dominated by governments to one with more involvement of water users. This paper integrates two tools for strengthening demand-based planning. On one hand, contingent

valuation (CV) surveys can be used to determine the preferences of households for improved water facilities and the amounts they are willing to pay for them, and on the other, mathematical models built around CV survey results can be used to identify and screen alternatives to meet the objectives of improved water supply. This paper reports a CV study conducted in Rwanda in 2000 and shows how the findings can be embedded in optimization models that can be used by stakeholders for addressing the key planning questions. The models are applied to a test case in Rwanda; the approach, however, is general and is expected to have wide application.

- [149] R Hosier and P O'Keefe. Planning to meet Kenya's household energy needs: An initial appraisal. *GeoJournal*, 7(1):29–34, January 1983.

KEY: HosiOkee1983

ANNOTATION: This article examines the possibilities of meeting household energy need in Kenya. Household energy consumption is the most significant sectoral energy consumption in Kenya. Despite uncertainties which make accurate projection impossible, it is useful to establish a quantitative planning framework for energy. Utilizing several approaches, from project appraisal, the authors conclude that wood is the most viable source of household energy for the short and medium term.

- [150] M A Jabbar, R von Kaufmann, and S K Ehui. Supply and demand for livestock credit in sub-Saharan Africa: Lessons for designing new credit schemes. *World Development*, 30(6):1029–1042, June 2002.

KEY: JabbEtAl2002

ANNOTATION: Based on analysis of credit supply in Ethiopia, Kenya, Uganda and Nigeria, it is shown that public credit institutions do not have sufficient funds to meet the demand for livestock credit and cannot mobilize savings from their clients or other commercial sources for one reason or another. In addition, available credit does not reach those who need it the most and with whom it could have the greatest impact due to the application of inappropriate screening procedures and criteria to determine creditworthiness. The analysis of demand based on borrowing and non-borrowing sample households using improved dairy technology shows that not all borrowers borrowed due to liquidity constraint while some borrowers and some non-borrowers had liquidity constraint but did not have access to adequate credit. Logistic regression analysis shows that sex and education of the household head, training in dairy, prevalence of outstanding loan and the number of improved cattle on the farm had significant influence on both borrowing and liquidity status of a household, though the degree and direction of influence were not always the same in each study country. Based on the findings it is suggested that combining public and commercial finance could solve the problem of inadequate credit supply while inventory finance to community level input suppliers and service providers might help in getting credit to worthy and needy smallholders at lower cost than providing credit to smallholders directly.

- [151] Monica C. Jackson, Laura Johansen, Cathy Furlong, Abigail Colson, and Kimberly F. Sellers. Modelling the effect of climate change on prevalence of malaria in western Africa. *Statistica Neerlandica*, 64(4):388–400, 2010. publisher: Blackwell Publishing Ltd; ISSN: 1467-9574; also available as: //dx.doi.org/10.1111/j.1467-9574.2010.00453.x.

KEY: JackEtAl2010

ANNOTATION: Malaria is a leading cause of infectious disease and death worldwide. as a common example of a vector-borne disease, malaria could be greatly affected by the influence of climate change. Climate impacts the transmission of malaria in several ways, affecting all stages of the disease's development. Using various weather-related factors that influence climate change, this study utilizes statistical analysis to determine the effect of climate change on reported malaria rates in an African region with endemic malaria. It examines the relationship between malaria prevalence and climate in western Africa using spatial regression modeling and tests for correlation. Our analysis suggests that minimal correlation exists between reported malaria rates and climate in western Africa. This analysis further contradicts the prevailing theory that climate and malaria prevalence are closely linked and negates the idea that climate change will increase malaria transmission in this region.

- [152] B Jacobs and A Mercer. Feasibility of hospital-based blood banking: A Tanzanian case study. *Health Policy and Planning*, 14(4):354–362, 1999.

KEY: JacoMerc1999

ANNOTATION: The demand for blood transfusion is high in sub-Saharan Africa because of the high prevalence of anaemia and pregnancy related complications, but the practice is estimated to account for 10% of HIV infections in some regions. The main response to this problem by the international donor community is to establish vertically implemented blood transfusion services producing suitable (safe) blood at a cost of US\$25-40 per unit. However, the economic sustainability of such interventions is questionable and it is argued here that hospital-based blood transfusion

services operating at a basic adequate level are sufficient for low-income African countries. The results of a project aimed at improving such services in Tanzania are presented. The main findings are: (1) the cost per suitable blood unit produced was US\$12.4; (2) at an HIV test sensitivity of 93.5% during the study period, discounted financial benefits of the interventions exceeded costs by a factor of between 17.2 and 37.1; (3) the cost per undiscounted year of life saved by use of these interventions was US\$2.7-2.8; and (4) safe blood transfusion practices can be assured at an annual cost of US\$0.07 per capita. Recommendations are made to ensure safe blood transfusion practices at hospital-based blood banks in Tanzania.

- [153] Hanan G Jacobya and Bart Minten. On measuring the benefits of lower transport costs. *Journal of Development Economics*, 89(1):28 – 38, May 2009.

KEY: JacoMint2009

ANNOTATION: Despite large amounts invested in rural roads in developing countries, little is known about their benefits. This paper derives an expression for the willingness-to-pay for a reduction in transport costs from the canonical agricultural household model and uses it to estimate the benefits of a hypothetical road project. Estimation is based on novel cross-sectional data collected in a small region of Madagascar with enormous, yet plausibly exogenous, variation in transport cost. A road that essentially eliminated transport costs in the study area would boost the incomes of the remotest households those facing transport costs of about \$75/ton by nearly half, mostly by raising non-farm earnings. This benefit estimate is contrasted to one based on a hedonic approach.

- [154] T S Jayne, J Strauss, T Yamano, and D Molla. Targeting of food aid in rural Ethiopia: Chronic need or inertia? *Journal of Development Economics*, 68(2):247–288, 2002.

KEY: JaynEtAl2002

ANNOTATION: This paper quantifies the factors underlying the allocations of food aid by the Ethiopian government, together with local and international non-governmental organizations (NGOs), both across rural regions and to households within regions. We focus on “reduced form” specifications in which as little structure as possible is put on the decision rules, because so little is known about these rules and their implementation. Nationally representative, rural household data from Ethiopia, collected in 1996, are used. The paper determines the extent to which food aid (both free distribution and food-for-work) is targeted to poor households and communities. We also demonstrate that food aid allocations display a large degree of spatial continuity over time, and are concentrated in areas that, at least during the time of the survey, are not the poorest. The paper attempts to disentangle two competing explanations for the apparent spatial rigidity of food aid allocations: that the recipient areas are chronically needy, or that needs shift geographically from 1 year to the next, but that fixed costs in setting up operations and in the process of identifying needs lead to a degree of inertia in the location of food aid programs over time. We conclude that the evidence best fits the inertia explanation.

- [155] F Jeltsch, T Stephan, S J Milton, W R J Dean, and N Van Rooyen. Wasserstellen in der südlichen Kalahari—ein räumliches Simulationsmodell. *Verbuschungsdynamik an Verhandlungen der Gesellschaft für Ökologie*, 26:435–442, 1996.

KEY: JeltEtAl1996

ANNOTATION:

- [156] Marc Jeuland, Marcelino Lucas, John Clemens, and Dale Whittington. A Cost-Benefit Analysis of Cholera Vaccination Programs in Beira, Mozambique. *World Bank Economic Review*, 23(2):235–267, 2009.

KEY: JeulEtAL2009

ANNOTATION: Economic and epidemiological data collected in Beira, Mozambique, are used to conduct this first social cost-benefit analysis for cholera vaccination in Sub-Saharan Africa. The analysis compares the net economic benefits of three immunization strategies with and without user fees: school-based vaccination for school children only (age 5-14), school-based vaccination for all children (age 1-14), and a mass vaccination campaign for all people older than one year. All options assume the use of a low-cost new-generation oral cholera vaccine. The analysis incorporates the latest knowledge of vaccine effectiveness, including new evidence on the positive externality associated with the resulting herd protection (both protection of unvaccinated individuals and enhanced protection among vaccinated individuals arising from vaccination of a portion of the population). It also uses field data for incidence, benefits (private willingness to pay, public cost of illness), and costs (production, shipping, delivery, private travel costs). Taking herd protection into account has important economic implications. For a wide variety of parameters values, vaccination programs in Beira pass a cost-benefit test. Small school-based programs with and without user fees are very likely to provide net benefits. A mass vaccination campaign without user fees would

result in the greatest reduction in the disease burden, but the social costs would likely outweigh the benefits, and such a program would require substantial public sector investment. As user fees increase, mass vaccination becomes much more attractive, and the reduction in disease burden remains above 70 percent at relatively low user fees.

- [157] Raphael M Jingura and Rutendo Matengaifa. Optimization of biogas production by anaerobic digestion for sustainable energy development in Zimbabwe. *Renewable and Sustainable Energy Reviews*, 13(5):1116 – 1120, 2009.

KEY: JingMate2009

ANNOTATION: There is increasing international interest in developing low carbon renewable energy technologies. Biomass is increasingly being utilized as an energy source throughout the world. Several modern technologies have been developed that convert biomass to bioenergy. Anaerobic digestion is a mature energy technology for converting biomass to biogas, which is a renewable primary energy source. Biogas is a robust fuel that can be used to supply heat, electricity, process steam and methanol. There are vast biomass resources in Zimbabwe that have good potential for biogas production by anaerobic digestion. However, anaerobic digestion is not being optimally used as a biomass conversion technology in the country. This paper presents an overview of biogas production in Zimbabwe and outlines technical options that can be utilized to optimize biogas production by anaerobic digestion in the country.

- [158] Sandra Johnson, Kerrie Mengersen, Alta de Waal, Kelly Marnewick, Deon Cilliers, Ann Marie Houser, and Lorraine Boast. Modelling cheetah relocation success in southern Africa using an Iterative Bayesian Network Development Cycle. *Ecological Modelling*, 221(4):641 – 651, 2010.

KEY: JohnEtAl2010

ANNOTATION: Relocation is one of the strategies used by conservationists to deal with problem cheetahs in southern Africa. The success of a relocation event and the factors that influence it within the broader context of long-term viability of wild cheetah metapopulations was the focus of a Bayesian Network (BN) modelling workshop in South Africa. Using a new heuristics, Iterative Bayesian Network Development Cycle (IBNDC), described in this paper, several networks were formulated to distinguish between the unique relocation experiences and conditions in Botswana and South Africa. There were many common underlying factors, despite the disparate relocation strategies and sites in the two countries. The benefit of relocation BNs goes beyond the identification and quantification of the factors influencing the success of relocations and population viability. They equip conservationists with a powerful communication tool in their negotiations with land and livestock owners, which is key to the long-term survival of cheetahs in southern Africa. Importantly, the IBNDC provides the ecological modeller with a methodological process that combines several BN design frameworks to facilitate the development of a BN in a multi-expert and multi-field domain.

- [159] Mahmoud A Kaboudan. Econometric model for Zimbabwe's future electricity consumption. *Energy*, 14(2):75–85, 1989.

KEY: Kabo1989

ANNOTATION: An econometric model to forecast electricity consumption in Zimbabwe through the year 2010 using 20 years of data (1965-1984) is presented. The model is a nonlinear dynamic system of simultaneous equations relating macroeconomic and demographic variables to electricity consumption. Its purpose is to provide projections of electricity consumption to forecast the country's maximum demand for electricity.

- [160] J Kabubo-Mariara. Resource allocation in socio-ecological systems: Implications for sustainable rangeland management in Kenya. *Annals of Arid Zone*, 45(3-4):437–451, 2006.

KEY: Kabu2006

ANNOTATION: This paper explores resource allocation decisions in Kenyan rangelands. We analyze choice decision of the producer to enter or not to enter livestock production, and the determinants of the optimal herd size. We apply the Heckman two-stage estimation procedure to correct for selectivity bias in the livestock production, optimal income and optimal herd size process. The results show that tenure security, assets and location of the household are important determinants of the decision to hold livestock and the optimal stocking rates and incomes. We find no evidence of selectivity bias in the decision to hold livestock, but there is self-selection in participation in livestock production and the optimal stocking rates. Main barriers to sustainable range management are identified to include population pressure, institutional constraints and poverty. Strategies focusing on elimination of these barriers are recommended.

- [161] Reuben M J Kadigi, Ntengua S Y Mdoe, Gasper C Ashimogo, and Sylvie Morardet. Water for irrigation or hydropower generation? Complex questions regarding water allocation in Tanzania. *Agricultural Water Management*, 95(8):984 – 992, 2008.

KEY: KadiEtAl2008

ANNOTATION: The need for achieving efficient, equitable and sustainable use of water resources to meet water demands of different sectors is pressing, particularly in areas where water resources are dwindling. Along with this is the quest for having a good understanding of the value of water in its different uses. Using a simplified model derived from the residual imputation approach (the Change in Net Income Model) we assess the value of water in irrigated paddy and hydropower generation in the Great Ruaha River Catchment (GRRC) in Tanzania. The estimated productivity of water (PW) in irrigated paddy ranges from 0.059 to 0.250 kg/m³ (for withdrawn water) and 0.126 to 0.265 kg/m³ (for consumed water). The PW in hydropower generation is estimated to range from 0.45 to 1.68 kWh/m³. In monetary terms the value of water in irrigated paddy is estimated at 15.3 Tanzanian shilling (Tsh)/m³ (for water withdrawn) and 0.19 Tsh/m³ (for water consumed). The values of water for hydropower generation are relatively higher than for irrigated paddy, ranging from 59 to 226 Tsh/m³. Yet, irrigated paddy also supports livelihoods of about 30,000 agrarian families in the GRRC, with gross revenue of about Tsh 15.9 million per annum and GRCC paddy contributes about 14-24% of national rice production. We conclude that understanding the value of water in its alternative uses is key to fostering informed debate on water management and allocation, identifying the basis for making [‘]agreeable’ trade-offs, the potential for improvement and creating linkages with water allocation options particularly in agricultural-based economies, where agriculture competes with other sectors and where water re-allocation decisions may involve large transfers of water from the sector generating the highest pro-poor returns (agriculture for this case) to the sectors generating the highest economic returns (hydropower generation and industrial uses).

- [162] A G Kagiannas, T Didis, D T Askounis, and J Psarras. Strategic appraisal of energy models for Mozambique. *International Journal of Energy Research*, 27(2):173–186, February 2003.

KEY: KagiEtAl2003

ANNOTATION: The needs that an energy supply system must meet are constantly changing, due to technological, social and political reasons. Effective energy planning is a dynamic process that is repeated periodically and adjusts to changing conditions. Energy decision makers and planners are no longer able to rely on inductive decision making since they have to investigate the effect of various decision parameters and possible future changes. To help in this process, models have been developed where estimates of future load growth, candidate power plants, fuels and other key factors can be introduced, from which the planners can evaluate decision parameters and the available alternatives. The paper presents the different methodologies and practices that are used by 11 energy models for energy demand forecasting, supply side management and generation expansion planning, demand side management and integrated resource planning. The paper concludes to the presentation of a strategic appraisal of the examined energy models appropriate for energy planning in Mozambique. Three models are proposed for conducting demand forecasting, generation expansion planning and demand side management.

- [163] Aloyce R M Kaliba, Thomas L Marsh, and David W Norman. Neighbourhood influence on economic efficiency of community based rural water utilities in central Tanzania: A spatial Tobit model. Available at: http://www.uaex.edu/akaliba/Documents/spatia_1.pdf, accessed 26:October:2010, 2007.

KEY: KaliEtAl2007

ANNOTATION: Data on village/community based water utilities from fifteen villages in each of two regions in Central Tanzania enabled estimation of economic efficiency measures using mathematical programming. Results indicate that, on average, water supply per village could be increased by 41% in Dodoma Region and 61% in Singida Region through choosing the technology and input combinations that are economically efficient. A spatial Tobit model was specified and used to determine the influence of community participation and sustainability indicators on economic efficiency. The results indicated that, while they are indeed important in ensuring economic sustainability, utilities clustered together are likely to be more economically inefficient than dispersed utilities. This implies that policies based on administrative boundaries are inappropriate. Project design may be better based on demand for water to take advantage of economies of scale.

- [164] Aloyce R M Kaliba and David W Norman. Assessing sustainability of community-based water utility projects in central Tanzania with the help of canonical correlation analysis. *Journal of Environmental Assessment Policy and Management*, 6(1):73–90, March 2004.

KEY: KaliNorm2004

ANNOTATION: Improved access to clean water is important in improving health, relieving drudgery for women, and in designing and implementing effective poverty alleviation strategies. However, few

empirical studies have had the objective of establishing the link between community participation and management, and sustainability of community based water utility projects. In addition, there is no consensus on the analytical techniques to use for sustainability assessment. This paper uses data collected from community water utility projects in two regions in Central Tanzania to demonstrate the use of canonical correlation analysis in sustainability assessment. The advantage of canonical correlation analysis is that the results are invariant with respect to the basis in which the variables are transformed. In addition, the analytical technique leads itself to identifying what management issues need to be addressed at the project level, to improve both community participation and management, and hence sustainability of such types of projects.

- [165] Courage Kamusoko, Masamu Aniya, Bongo Adi, and Munyaradzi Manjoro. Rural sustainability under threat in Zimbabwe – Simulation of future land use/cover changes in the Bindura district based on the Markov-cellular automata model. *Applied Geography*, 29(3):435 – 447, 2009.

KEY: KamuEtAl2009

ANNOTATION: Spatially explicit land use/cover models are indispensable for sustainable rural land use planning, particularly in southern African countries that are experiencing rapid land use/cover changes. Using Zimbabwe as an example, we simulated future land use/cover changes up to 2030 based on a Markov-cellular automata model that integrates Markovian transition probabilities computed from satellite-derived land use/cover maps and a cellular automata spatial filter. A multicriteria evaluation (MCE) procedure was used to generate transition potential maps from biophysical and socioeconomic data. Dynamic adjustments of transition probabilities and transition potential map thresholds were implemented in the Markov-cellular automata model through a multi-objective land allocation (MOLA) procedure. Using the normalised transition probabilities, the Markov-cellular automata model simulated future land use/cover changes (up to 2030) under the 2000 calibration scenario, predicting a continuing downward trend in woodland areas and an upward trend in bareland areas. Future land use/cover simulations indicated that if the current land use/cover trends continue in the study area without holistic sustainable development measures, severe land degradation will ensue.

- [166] A R S Kaoneka and B Solberg. Analysis of deforestation and economically sustainable farming systems under pressure of population growth and income constraints at the village level in Tanzania. *Agriculture, Ecosystems & Environment*, 62(1):59–70, March 1997.

KEY: KaonSolb1997

ANNOTATION: The main aim of this paper is to apply mathematical programming and welfare maximization theory to analyze the effect of population growth on agriculture/forest land use competition, per capita cash income and subsistence consumption from privately owned farms as a basis to determine the economic sustainability of the present farming systems in the West Usambara Mountains. Two working hypotheses are presented: (1) given present population growth trends, present farming systems are not economically sustainable; (2) population growth will cause deforestation over time due to the expansion of farmlands. The analysis presented in this paper indicates that the present farming systems can sustain the present population growth rate (2.1% per annum for Lukozi Village) and per capita income for a maximum duration of 25-30 years. Life expectancy in Tanzania is over 45 years (based on 1988 population census). Thus, the present farming systems cannot sustain even one human generation. This suggests that, for the existing farming systems to become economically sustainable, it is important to improve farming technology which could increase crop production through improvements of land productivity, and to increase income from other sources. Such a strategy will meet the increased food demand as a result of population growth as well as limiting the expansion of farmlands through forest clearing. In addition, the welfare of the farmers and rural populace could be enhanced and improved. Also, it might be relevant to expand small-scale industrial activities to increase income from off-farm activities.

- [167] Lydia Kapiriri, Ole F Norheim, and Douglas K Martin. Fairness and accountability for reasonableness. Do the views of priority setting decision makers differ across health systems and levels of decision making? *Social Science & Medicine*, 68(4):766 – 773, 2009.

KEY: KapiEtAl2009

ANNOTATION: Accountability for reasonableness is an ethical framework for fair priority setting process. This framework has been used to evaluate fairness in several contexts, and a few studies have evaluated its acceptability to decision makers. However, no studies have compared the acceptability of the four conditions of the framework to decision makers across health systems and levels of priority setting. This paper reports the elements of fairness described by 184 decision

makers involved in priority setting at the macro-, meso- and micro-levels of priority setting in the Canadian (Ontario), Norwegian and Ugandan health care systems and compares them against the four conditions of 'Accountability for Reasonableness' and across levels of decision making, and health care systems. Our respondents identified 23 elements of fair priority setting. Most of these (17) were well aligned with the four conditions of Accountability for Reasonableness; six were not. Comparisons across health care system and levels of decision making revealed that four elements (transparency, participatory and among the criteria-need based and objective) were common to all and the rest were common to only the health care systems (but not at all levels), or only the levels of decision making (but not to all health care systems). Perceptions varied remarkably across levels of decision making. The overlap between the elements of fairness found in this study and the conditions of Accountability for Reasonableness demonstrates that the four conditions are recognizable and applicable across health care systems and levels of decision making. However, the framework should be used with flexibility to allow for identification of elements and relevant explicit criteria (such as those identified in this study) - that may not directly fit under any of the four conditions.

- [168] Menale Kassie, M A Jabbar, and B Kassa. An analysis of the implications of forage legumes and a cereal-based cropping system for sustainable agriculture in Ethiopia: A linear programming approach. *Science, Technology and Development*, 16(3):32-50, 1998.
 KEY: KassEtA11998
 ANNOTATION: One of the factors that constrains animal draft power in livestock-rich countries like Ethiopia is the inadequate supply of livestock feed both in quantitative and qualitative terms. This problem in Ethiopia is aggravated by poor soil conditions across the highland areas. Inter-cropping of forage legumes with cereal crops can restore soil fertility, reduce the need for imported inputs, alleviate the problem of shortfalls in the quality and quantity supply of livestock feed, and enhance the draft power efficiency of oxen. Nitrogen (N) input from forage legumes can help maintain the soil N reserve as well as substituting for inorganic fertilisers to attain large crop yields. Using a linear programming model, this article examines the economic impacts of the inter-cropping system that combines forage and food crop cultivation, based on resources available to farmers and on prevailing agricultural practices in the Ethiopian highlands.
- [169] Menale Kassie, M A Jabbar, B Kassa, and M A Mohamed Saleem. Benefits of integration of cereals and forage legumes with and without crossbred cows in mixed farms: An ex ante analysis for highland Ethiopia. *Journal of Sustainable Agriculture*, 14(1):31-48, 1999.
 KEY: KassEtA11999
 ANNOTATION: Poverty, low crop and animal productivity and large-scale resource degradation are major problems in the agriculture sector in the East African highlands. Among others, integration of forage legumes in cereal based cropping systems has been proposed as a promising strategy to improve the sustainability of smallholder farming systems through increased crop and livestock productivity and better soil management. Using experimental data from Ethiopia and elsewhere in the region, linear programming models have been used to determine the economic impacts of cereal-forage legume inter-cropping with and without crossbred cows for a typical highland mixed farm. An important feature of the model was that the benefits of inter-cropping in terms of nitrogen fixation and the better nutrition of animals were accounted for. Model results demonstrate that the introduction of forage legumes with cereals changes cropping pattern significantly, but does not significantly change the use pattern of principal farm resources, labor and ox power. Introduction of cereal-forage legume inter-cropping significantly increases gross margin and cash income, and the introduction of crossbred cows enhances these returns even further. Inter-cropping also significantly increases the share of livestock in farm and cash income when crossbred cows are included. Sensitivity analyses show that the improved technologies remain more profitable than current practices even when there is a substantial decrease in price of outputs. The results indicate that the improved production technologies should be widely tested under actual farm conditions under farmer management through on-farm research and extension. Benefits of inter-cropping in terms of weed control and control of soil erosion should be quantified in future research.
- [170] Menale Kassie, John Pender, Mahmud Yesuf, Gunnar Kohlin, Randy Bluffstone, and Elias Mulugeta. Estimating returns to soil conservation adoption in the northern Ethiopian highlands. *Agricultural Economics*, 38(2):213-232, 2008.
 KEY: KassEtA12008
 ANNOTATION: Land degradation in the form of soil erosion and nutrient depletion presents a threat

to food security and sustainability of agricultural production in many developing countries. Governments and development agencies have invested substantial resources to promote soil conservation practices as part of an effort to improve environmental conditions and reduce poverty. However, limited rigorous empirical work has been done on the economics of soil conservation technology adoption. This article investigates the impact of stone bunds on value of crop production per hectare in low and high rainfall areas of the Ethiopian highlands using cross-sectional data from more than 900 households, with multiple plots per household. We have used modified random effects models, stochastic dominance analysis (SDA), and matching methods to ensure robustness. The parametric regression and SDA estimates are based on matched observations obtained from the nearest neighbor matching using propensity score estimates. This is important, because conventional regression and SDA estimates are obtained without ensuring that there actually exist comparable conserved and nonconserved plots on the distribution of covariates. We use matching methods, random effects, and Mundlak's approach to control selection and endogeneity bias that may arise due to correlation of unobserved heterogeneity and observed explanatory variables. We find that the three methods tell a consistent story. Plots with stone bunds are more productive than those without such technologies in semi-arid areas but not in higher rainfall areas, apparently because the moisture conserving benefits of this technology are more beneficial in drier areas. This implies that the performance of stone bunds varies by agro-ecology type, suggesting the need for designing and implementing appropriate site-specific technologies.

- [171] S Kayaga and R Franceys. Water services regulation for the urban poor: Zambia. *Water Management*, 161(2):65–71, March 2008.

KEY: KayaFran2008

ANNOTATION: There is rapid urbanisation in developing countries, where UN Habitat estimates that 80% of the world urban population will live by 2030. Urban water utilities are facing a challenge of continuously extending services to the rapidly expanding towns and cities, particularly so when most of the population growth is absorbed by slums, leading to an increasing number of the urban poor. Economic regulation of urban water service providers is therefore necessary to guard the equity principle and promote universal water service coverage that is an overarching target for achievement of UN millennium development goals. This paper reports on research carried out in Lusaka, Zambia, one of seven case studies in a global research study on whether the needs of the urban poor have been incorporated, as a primary duty of regulation. The study found that NWASCO, the Zambian regulator, has made commendable progress towards 'good regulation' principles of independence, accountability, consistency, transparency, proportionality and equitable targeting of interventions. Clearly, there are good lessons for policy makers in other developing countries to learn from the way regulation structures, systems and procedures were set up in Zambia, and how they have evolved over time. Increased consumer participation will make the regulatory regime more pro-poor.

- [172] S Kayaga and C Kadimba-Mwanamwambwa. Bridging Zambia's water service gap: NGO/community partnerships. *Water Management*, 159(3):155–160, September 2006.

KEY: KayaKadi2006

ANNOTATION: Although the world's urban population has in the last 50 years increased fourfold, investment in water and sanitation services infrastructure in low-income countries has not kept pace with this population growth. Consequently, between 30 and 60% of the urban population is not adequately served. Invariably, poor people bear a disproportionate share of the impact of low service levels and are forced to adopt coping mechanisms, ranging from group connections to reliance on traditional water supply and sanitation systems, which are often technically unsuitable to the urban environment. This paper presents a case study in which CARE International set up an independent community-managed 'Water Trust' system to serve about 85 000 people in Kanyama, a low-income settlement in Lusaka, Zambia. A recent evaluation study showed that, compared to services delivered by Lusaka Water and Sewerage Company, the legitimate water utility, the Water Trust system was delivering water services of better quality and in a cost-effective manner. Further study needs to be done on the optimum institutional arrangement to ensure that communities served by the Water Trust fully benefit from the regulatory regime currently taking a firm grip in Zambia.

- [173] Michael Keen and Mario Mansour. Revenue mobilisation in sub-Saharan Africa: Challenges from globalisation i trade reform. *Development Policy Review*, 28(5):553–571, 2010. publisher: Blackwell Publishing Ltd, ISSN: 1467-7679, also available as: [//dx.doi.org/10.1111/j.1467-7679.2010.00498.x](http://dx.doi.org/10.1111/j.1467-7679.2010.00498.x).

KEY: KeenMans2010a

ANNOTATION: This is the first of two articles evaluating the nature and extent of, and possible responses to, two of the central challenges that globalisation poses for revenue mobilisation in sub-Saharan Africa: trade liberalisation, and corporate tax competition. Both articles use a new dataset with the features needed to address these issues meaningfully: a disentangling of tariff from commodity tax revenue, and a distinction between resource-related and other revenues. This first article describes that dataset, and provides a broad picture of revenue developments in the region between 1980 and 2005. Countries experiences have varied, but the overall picture is of non-resource revenues having been essentially stagnant. Within this, however, and with exceptions, reductions in trade tax revenue have been largely offset by increased revenue from domestic sources.

- [174] Michael Keen and Mario Mansour. Revenue mobilisation in sub-Saharan Africa: Challenges from globalisation ii corporate taxation. *Development Policy Review*, 28(5):573–596, 2010. publisher: Blackwell Publishing Ltd; ISSN: 1467-7679; also available as: [//dx.doi.org/10.1111/j.1467-7679.2010.00499.x](https://dx.doi.org/10.1111/j.1467-7679.2010.00499.x).

KEY: KeenMans2010b

ANNOTATION: This second article evaluates and discusses the challenges to government revenue in sub-Saharan Africa posed by developments in corporate taxation. Using the dataset described in the first article, it shows that, in broad terms, corporate tax revenues in the region have held up, despite a reduction in rates and evidence of substantial base-narrowing (mainly through the provision of tax holidays in Investment Codes and Free Zones). This is something of a puzzle. Options for dealing with the continuation and intensification of the challenges to these revenues, including through regional co-operation, are discussed.

- [175] David Kemball-Cook and David J Wright. The search for appropriate O.R.: A review of operational research in developing countries. *Journal of the Operational Research Society*, 32(11):1021–1037, November 1981.

KEY: KembWrig1981

ANNOTATION: This paper is a review of the literature relating to the application of O.R. in developing countries. The paper attempts to identify the special factors which affect decision problems in Developing countries. Some desirable characteristics for O.R. in this context are outlined. The paper then summarises the results of a review of published studies, and some criticisms are made of current O.R. work.

- [176] Hailu Kidane. Economics constraints of smallholder milk production in Kenya: A linear programming approach. *Borneo Review, Journal of the Institute for Development Studies (Sabah)*, 4(2):161–173, December 1993.

KEY: Kida1993

ANNOTATION:

- [177] Yoko Kijima, Keijiro Otsuka, and Dick Sserunkuuma. An inquiry into constraints on a green revolution in sub-Saharan Africa: The case of NERICA rice in Uganda. *World Development*, 39(1):77–86, 2011.

KEY: KijiEtAl2011

ANNOTATION: Summary In Uganda, New Rice for Africa (NERICA), a high-yielding upland rice variety suitable for the African environment, was introduced to increase food security and reduce poverty in rural areas in 2002. However, more than 50% of the NERICA adopters in 2004 had abandoned it in 2006. The regression results indicate that the low profitability of NERICA relative to alternative crops in variable rainfall areas explains the massive dropout. It is also found that the profitability of NERICA production was low when farmer-produced seeds were used in 2006, suggesting the weak dissemination of appropriate information on seed production to rice farmers.

- [178] Gregory A Kiker, Rafael Munoz-Carpena, Piotr Wolski, Anna Cathey, Andrea Gaughan, and Jongbum Kim. Incorporating uncertainty into adaptive, transboundary water challenges: a conceptual design for the Okavango River basin. *International Journal of Risk Assessment and Management*, 10(4):312–338, 2008.

KEY: KikeEtAl2008

ANNOTATION: In this paper, we present a review and conceptual design to integrate hydrological/ecological models, global uncertainty and sensitivity analysis, integrative modelling and decision analysis for complex and adaptive transboundary challenges. The research uses the transboundary issues within the Okavango River basin, a shared water resource among the nations of Angola, Namibia and Botswana, as an example for constructing these integrated tools. The objective of this paper is to present a design that integrates a set of tools that builds systematically on past basin modelling research to incorporate the inherent uncertainty within the system and its application for answering practical management questions.

- [179] E C Kipkorir, D Raes, and J Labadie. Optimization of the short term supply of irrigation water for a multicrop scheme when conflicts between supply and demand arises. *Water Studies*, 7:81–90, 2000.

KEY: KipkEtAl2000

ANNOTATION: An optimization approach has been developed to aid decision making in real time for deficit irrigation when conflict between water supply and demand arises in a multiple crop irrigation scheme. The result is the optimal allocation of short-term supply of irrigation water. The optimization approach is based on dynamic programming. In the optimization approach, the short-term supply is optimized in function of a specified strategy determined by the user. The strategies that the user can select from are: maximum revenue, equitable maximum yield and maintaining equity in the system. The potential of the approach has been assessed through application of the model to Perkerra irrigation scheme in Kenya. In the 680 ha scheme, maize, cotton, onions, chilies and watermelon are cultivated in the irrigation season. Analysis of the results for the 1991/1992 season, where the water supply was 15 percent smaller than the demand, indicates that improvements in crop production can be achieved through application of the optimization approach.

- [180] E C Kipkorir, D Raes, and J Labadie. Optimal allocation of short-term irrigation supply. *Irrigation and Drainage Systems*, 15(3):247–267, 2001.

KEY: KipkEtAl2001

ANNOTATION: An optimization model has been developed to aid decision making in real time for deficit irrigation when conflict between water supply and demand arises in a multiple crop irrigation scheme. The result is the optimal allocation of short-term supply of irrigation water. The optimization model is based on dynamic programming. In the optimization model, the short-term supply is optimized in function of a specified strategy determined by the user. The strategies that the user can select from are: maximum benefit, equitable benefit, equitable yield and maintaining equity in the system. The potential of the model has been assessed through application of the model to Perkerra irrigation scheme in Kenya. In the 680 ha scheme, maize, onion and chili are cultivated in the irrigation season. Analysis of the results for the 1999/2000 season, where the water supply was 35 percent smaller than the demand, indicates that improvements in crop production can be achieved through application of the optimization model. Sensitivity of production system to various levels of water restriction is demonstrated by sensitivity analysis.

- [181] Joses M Kirigia, Ali Emrouznejad, Basilio Cassoma, Eyob Zere Asbu, and Saidou Barry. A Performance Assessment Method for Hospitals: The Case of Municipal Hospitals in Angola. *Journal of Medical Systems*, 32(6):509–519, December 2008.

KEY: KiriEtAl2008

ANNOTATION: Over 60% of the recurrent budget of the Ministry of Health (MoH) in Angola is spent on the operations of the fixed health care facilities (health centres plus hospitals). However, to date, no study has been attempted to investigate how efficiently those resources are used to produce health services. Therefore the objectives of this study were to assess the technical efficiency of public municipal hospitals in Angola; assess changes in productivity over time with a view to analyzing changes in efficiency and technology; and demonstrate how the results can be used in the pursuit of the public health objective of promoting efficiency in the use of health resources. The analysis was based on a 3-year panel data from all the 28 public municipal hospitals in Angola. Data Envelopment Analysis (DEA), a non-parametric linear programming approach, was employed to assess the technical and scale efficiency and productivity change over time using Malmquist index. The results show that on average, productivity of municipal hospitals in Angola increased by 4.5% over the period 2000-2002; that growth was due to improvements in efficiency rather than innovation.

- [182] Joses M Kirigia, Ali Emrouznejad, and Luis G Sambo. Measurement of technical efficiency of public hospitals in Kenya, using data envelopment analysis. *Journal of Medical Systems*, 26:39–45, 2002.

KEY: KiriEtAl2002

ANNOTATION: In Sub-Saharan Africa, there is a huge knowledge gap of health facilities performance. The objective of this study is to measure relative technical efficiencies of 54 public hospitals in Kenya using Data Envelopment Analysis technique. 14 (26%) of the public hospitals were found to be technically inefficient. The study singled out the inefficient hospitals and provided the magnitudes of specific input reductions or output increases needed to attain technical efficiency.

- [183] Joses M Kirigia, Ali Emrouznejad, Luis G Sambo, N Munguti, and W Liambila. Using data envelopment analysis to measure the technical efficiency of public health centers in Kenya. *Journal of Medical Systems*, 28:155–166, 2004.

KEY: KiriEtAl2004

ANNOTATION: Data Envelopment Analysis has been widely used to analyze the efficiency of health sector in developed countries, since 1978, while in Africa, only a few studies have attempted to

apply DEA in the health organizations. In this paper we measure technical efficiency of public health centers in Kenya. Our finding suggests that 44% of public health centers are inefficient. Therefore, the objectives of this study are: to determine the degree of technical efficiency of individual primary health care facilities in Kenya; to recommend the performance targets for inefficient facilities; to estimate the magnitudes of excess inputs; and to recommend what should be done with those excess inputs. The authors believe that this kind of studies should be undertaken in the other countries in the World Health Organization African Region with a view to empowering Ministries of Health to play their stewardship role more effectively

- [184] Joses M Kirigia, Luis G Sambo, Margaret Phiri, Gladys Matsembula, and Magda Awases. Cost-effectiveness analysis of establishing a distance-education programme for health personnel in Swaziland. *African Journal of Health Science*, 9(1-2):3-15, January 2002.

KEY: KiriEtAl2002b

ANNOTATION: There is a growing conviction among policy-makers that the availability of adequate numbers of well-trained and motivated human resources is a key determinant of health system's capacity to achieve their health, responsiveness and fairness-improving goals. The objective of this study was to estimate the cost, effectiveness and incremental cost-effectiveness ratios of various distance-education strategies for the health sector in Swaziland; and recommend the most cost-effective option. The distance-education strategies evaluated included: Mobile library services (MLS); micro-resources centers WITHOUT video conferencing in five health centers and four regional hospitals (MRC-VC); micro-resources centers WITH video conferencing in five health centers and four regional hospitals (MRC+VC); centralized resource center WITHOUT video conferencing (CRC-VC); centralized resource center WITH video conferencing (CRC+VC); and status quo (SQ). The incremental cost-effectiveness ratio for MLS was Emalangeni (E) 41,846; MRC-VC was E42,696; MRC+VC was E45,569; CRC-VC was E43,578; CRC+VC was E40,827; the latter being the most cost-effective distance-education strategy. According to policy-makers, this study served to clarify the various distance-education strategies, their costs and their benefits/effectiveness. There is a need for developing in Africa a culture of basing policy and management decisions of such kind on systematic analyses. Of course, economic evaluation will, at most, be a guide to policy- and decision-making, and thus, the onus of decision-making will always be on policy-makers and health-care managers.

- [185] Frank Kizito, Harrison Mutikanga, Gaddi Ngirane-Katashaya, and Roger Thunvik. Development of decision support tools for decentralised urban water supply management in Uganda: An Action Research approach. *Computers, Environment and Urban Systems*, 33(2):122 - 137, 2009.

KEY: KiziEtAl2009

ANNOTATION: This paper presents a study in which four real-life problem situations are used to explore the challenges of developing and implementing decision support tools within an urban water utility. In the study, an Action Research approach is used, with theoretical considerations leading to specific actions being implemented, which in turn yield results that are used to reflect upon the original theoretical assumptions. Results of the study emphasize the need for proper problem-structuring prior to the formulation of actions; the challenges of moving from planning to action; the importance of user involvement in the development of tools; and how a good match of people, problem-structuring, proactiveness and participatory tools development is required for effective decision support provision. The study also highlights the challenges of embedding decision support within existing work systems in organizations. The Action Research approach is shown to be useful in bridging the gap between theory and practice, aiding the development of decision support tools of immediate and practical benefit to organizations.

- [186] Heather Klemick, Kenneth L Leonard, and Melkiory C Masatu. Defining Access to Health Care: Evidence on the Importance of Quality and Distance in Rural Tanzania. *American Journal of Agricultural Economics*, 91(2):347-358, May 2009.

KEY: KlemEtAl2009

ANNOTATION: We examine the implications of health-seeking behavior on access to quality health care using a unique dataset that combines a household survey from rural Tanzania with the location and quality of all health facilities available to households. Patients do not always visit the nearest facility, but choose from among multiple facilities, improving the quality of care they receive by bypassing low quality facilities. Recognizing this behavior alters the projected benefits to health interventions, reducing the value of focusing on the staff qualifications and increasing the value of focusing on travel time and the motivation of current staff.

- [187] G Cornelis van Kooten, Erwin H Bulte, and Patrick Kinyua. Game cropping and wildlife conservation in Kenya: a dynamic simulation model with adaptive control. *Agricultural Systems*, 54:439–462, 1997.
KEY: KootEtAl1997
ANNOTATION: The authors use a dynamic stochastic simulation model of forage, herbivores, predators and domestic livestock in the Machakos District of Kenya to address policies related to the multiple use of rangeland resources. The particular policy examined is that of switching from a traditional system, where commercial ranchers do not harvest wildlife herbivores, to one where ranchers are provided economic incentives to adopt multiple-use management of the range resource. Simulations using an adaptive controller indicate that the effects of the policy change on wildlife populations depend on the conditions of the ecosystem and, importantly, on ranchers' attitudes to risk. When forage is abundant, and game and livestock do not compete for food, the policy change leads to reduced wildlife populations, especially of the relatively more valuable species. However, in periods of drought when competition for forage occurs, the policy change may dampen the decline in game populations, as risk-averse ranchers may decide to sell more cattle and harvest wildlife instead. Game cropping reduces wildlife populations, but increases their stability.
- [188] G S Kowero and D P Dykstra. Improving long-term management plans for a forest plantation in Tanzania, using linear programming. *Forest Ecology and Management*, 24(3):203–217, 1988.
KEY: KoweDyks1988
ANNOTATION: Long-term planning for the management of multiple-species plantation forests can be a difficult undertaking, particularly when the forests have been created by afforestation over several decades so that the age-class structure of the compartments is seriously unbalanced. A time-staged linear programming model is developed to assist forest managers in such situations. The model is expressly designed to be small enough to permit solutions with microcomputers of the type available to forest managers even in many developing countries.
- [189] G S Kowero, I Nhantumbo, and H Tchale. Reconciling household goals in southern African woodlands using weighted goal programming. *International Forestry Review*, 7:294–304, 2005.
KEY: KoweEtAl2005
ANNOTATION: Weighted goal programming (WGP) is employed to reconcile the goals of food security, improved incomes and woodland conservation in households from selected sites in Malawi, Mozambique and Zimbabwe. The three goals are attainable simultaneously, albeit with trade-offs useful in guiding development of rural development policies. The WGP model provides a framework for evaluating impact, on the household goals and woodland condition, of some macroeconomic and sectoral policies and demographic changes.
- [190] Randall A Kramer, Katherine L Dickinson, Richard M Anderson, Vance G Fowler, Marie Lynn Miranda, Clifford M Mutero, Kathryn A Saterson, and Jonathan B Wiener. Using decision analysis to improve malaria control policy making. *Health Policy*, 92(2-3):133 – 140, 2009.
KEY: KramEtAl2009
ANNOTATION: Malaria and other vector-borne diseases represent a significant and growing burden in many tropical countries. Successfully addressing these threats will require policies that expand access to and use of existing control methods, such as insecticide-treated bed nets (ITNs) and artemisinin combination therapies (ACTs) for malaria, while weighing the costs and benefits of alternative approaches over time. This paper argues that decision analysis provides a valuable framework for formulating such policies and combating the emergence and re-emergence of malaria and other diseases. We outline five challenges that policy makers and practitioners face in the struggle against malaria, and demonstrate how decision analysis can help to address and overcome these challenges. A prototype decision analysis framework for malaria control in Tanzania is presented, highlighting the key components that a decision support tool should include. Developing and applying such a framework can promote stronger and more effective linkages between research and policy, ultimately helping to reduce the burden of malaria and other vector-borne diseases.
- [191] P M Kristjanson, B M Swallow, G J Rowlands, R L Kruska, and P N de Leeuw. Measuring the costs of African animal trypanosomosis, the potential benefits of control and returns to research. *Agricultural Systems*, 59(1):79–98, January 1999.
KEY: KrisEtAl1999
ANNOTATION: This paper addresses issues surrounding measurement of the potential productivity gains from new livestock technologies and the returns to international livestock research. The approach, applicable to many livestock production constraints and technologies, uses geographic information systems (GIS) to spatially link a biophysical herd simulation model with an economic

surplus model. The particular problem examined is trypanosomosis in cattle in Africa, and the potential research product is a multi-component vaccine. The results indicate that the potential benefits of improved trypanosomosis control, in terms of meat and milk productivity alone, are USD700 million per year in Africa. The disease now costs livestock producers and consumers an estimated USD1340 million annually, without including indirect livestock benefits such as manure and traction. Given an adoption period of 12 years, a maximum adoption rate of 30%, a discount rate of 5%, and a 30% probability of the research being successful within 10 years, the net present value of the vaccine research is estimated to be at least USD288 million, with an internal rate of return of 33%, and a benefit/cost ratio of 34:1.

- [192] Arnim Kuhn, Thomas Gaiser, and Esae Gandonou. Simulating the effects of tax exemptions on fertiliser use in Benin by linking biophysical and economic models. *Agricultural Systems*, 103(8):509–520, 2010.

KEY: KuhnEtAl2010

ANNOTATION: The sluggish increase in the area productivity of staple crops is a major factor causing increased dependence of African countries on food imports. The increased use of mineral fertiliser may dramatically improve the food balance of many countries and result in lower food prices, higher food supply and consumption, and improved food security and nutritional status. In Benin, West Africa, political measures to improve farmers' access to fertiliser are biased in favour of cotton production. This article simulates the impact of universal tax exemptions for fertiliser use on crop yields, food balances, and the use of land resources for the most important staple crops in Benin using a crop growth model and an agricultural sector model. The simulation results indicate that tax exemptions on fertiliser use could have positive effects on physical productivity and would increase food security until 2025 as compared to a baseline scenario. At the same time, the pressure on land resources would not be aggravated, so that better access to fertiliser may help to curb excessive cropland expansion in Benin.

- [193] Augustine S Langyintuo and Peter Setimela. Assessing the effectiveness of a technical assistance program: The case of maize seed relief to vulnerable households in zimbabwe. *Food Policy*, 34(4):377 – 387, 2009.

KEY: LangSeti2009

ANNOTATION: The recent economic downturn in Zimbabwe impoverished the majority of households. To assist vulnerable rural households improve their food security, the British Department for International Development implemented a seed relief program from 2003/2004 to 2005/2006 that emphasized recycling of maize open pollinated varieties (OPV). Using data collected from 597 households in six districts in 2006, this study assesses the effectiveness of the program in terms of its targeting of beneficiaries, the flow of information from participating NGOs to beneficiaries on the need to recycle the seeds, and the level of recycling done at the end of the program. The empirical results suggest that the targeting method participating NGOs use inadvertently excludes relatively vulnerable households while including large proportions of relatively well-endowed households in the program. The choice of varieties to distribute is guided more by the ecological adaptability of available commercial seeds and less by preferences of beneficiaries. Notwithstanding the fact that seed selection information is critical in encouraging beneficiaries to recycle distributed seed, not all of them received it. In conclusion, it may be stated that the program undoubtedly contributed to increased food productivity by vulnerable households but its overall effectiveness could have been enhanced through (i) the involvement of the beneficiaries in the choice of types of seed to be distributed, (ii) better targeting of beneficiaries, and (iii) improved information flow between NGOs and beneficiaries.

- [194] Philippe LeMay-Boucher. Beninese and Ethiopian informal insurance groups: A comparative analysis. *Development Policy Review*, 27(3):333–347, 2009. publisher: Blackwell Publishing Ltd; ISSN: 1467-7679; also available as: [//dx.doi.org/10.1111/j.1467-7679.2009.00449.x](http://dx.doi.org/10.1111/j.1467-7679.2009.00449.x).

KEY: Lema2009

ANNOTATION: Informal insurance groups have been created in many poor regions in response to a risky environment typical of developing countries. Drawing on original datasets from Benin and Ethiopia, this article provides empirical evidence describing the various forms these indigenous institutions take. While their principal role has been to provide indemnities for funeral expenses, they also cater for a wide range of shocks. The article finds striking resemblances in group structures and types of coverage offered, suggesting that households for whom the costs of formal insurance contracts are prohibitive tend to deal with risk in a comparable way. Dissimilarities may reflect different local household structures or the extent to which these groups are advertised and known to the public.

- [195] Stephanie Levy. Public investment to reverse Dutch disease: The case of Chad. *Journal of African Economies*, 16(3):439–484, June 2007.
KEY: Levy2007
ANNOTATION: This paper studies the relevance of agricultural policies for avoiding Dutch disease, which affects many less developed countries experiencing a resource boom. Using a computable general equilibrium model calibrated for Chad, we study the impact of using this country's annual oil revenue for public investment, particularly in the development of road and irrigation infrastructure. Our model takes into account the integration of markets and migration processes. We find that improving water access would reduce Chad's dependence on food aid and entail a substantial improvement in rural household welfare.
- [196] Yanyan Liu and Robert Myers. Model selection in stochastic frontier analysis with an application to maize production in Kenya. *Journal of Productivity Analysis*, 31(1):33–46, February 2009.
KEY: LiuMyer2009
ANNOTATION: This paper shows how to compute the standard errors for partial effects of exogenous firm characteristics influencing firm inefficiency under a range of popular stochastic frontier model specifications. We also develop an R-2-type measure to summarize the overall explanatory power of the exogenous factors on firm inefficiency. The paper also applies a recently developed model selection procedure to choose among alternative stochastic frontier specifications using data from household maize production in Kenya. The magnitude of estimated partial effects of exogenous household characteristics on inefficiency turns out to be very sensitive to model specification, and the model selection procedure leads to an unambiguous choice of best model. We propose a bootstrapping procedure to evaluate the size and power of the model selection procedure. The empirical application also provides further evidence on how household characteristics influence technical inefficiency in maize production in developing countries.
- [197] A R C Low. Decision taking under uncertainty - linear programming model of peasant farmer behaviour. *Journal Of Agricultural Economics*, 25(3):311–321, 1974.
KEY: Low1974
- [198] Yoel Lubell, Heidi Hopkins, Christopher J M Whitty, Sarah G Staedke, and Anne Mills. An interactive model for the assessment of the economic costs and benefits of different rapid diagnostic tests for malaria. *Malaria Journal*, 7(21):11 pages, accessed 26:October:2010, January 2008.
KEY: LubeEtAl2008b
ANNOTATION: Background: Rapid diagnostic tests (RDTs) for malaria are increasingly being considered for routine use in Africa. However, many RDTs are available and selecting the ideal test for a particular setting is challenging. The appropriateness of RDT choice depends in part on patient population and epidemiological setting, and on decision makers' priorities. The model presented (available online) can be used by decision makers to evaluate alternative RDTs and assess the circumstances under which their use is justified on economic grounds. Methods: An interactive model based on a decision-tree structure and a cost-benefit framework was designed to compare different diagnostic strategies. Variables included in the model can be modified by users, including RDT and treatment costs, test accuracies (sensitivity and specificity), probabilities for developing severe illness, case-fatality rates, and clinician response to negative test results. To illustrate how the model can be used, a comparison is made of presumptive treatment with two available RDTs, one detecting histidine-rich protein-2 (HRP2) and one detecting Plasmodium lactate dehydrogenase (pLDH). Data inputs were obtained from a study comparing the RDTs at seven sites in Uganda. Results: Applying the model in the illustrative Ugandan context demonstrates that if only direct expenditures are considered, the pLDH test is the preferred option for adult patients except in high transmission settings, while young children are best treated presumptively in all settings. When health outcomes are considered, the HRP2 test gains an advantage in almost all settings and for all age groups. Introducing possible adverse consequences of using an antimalarial into the analysis, such as adverse drug reactions, or the development of resistance, considerably strengthens the case for using RDTs. When the model is adjusted to account for less than complete adherence to test results, the efficiency of using RDTs drops sharply. Conclusion: Model output demonstrates that which test is preferable varies by location, depending on factors such as malaria transmission intensity and the costs and accuracies of the RDTs under consideration. Despite the uncertainties and complexities involved, adaptable models such as the one presented here can serve as a practical tool to assist policy makers in efficient deployment of new technologies.

- [199] Yoel Lubell, Hugh Reyburn, Hilda Mbakilwa, Rose Mwangi, Semkini Chonya, Christopher J Whitty, and Anne Mills. The impact of response to the results of diagnostic tests for malaria: cost-benefit analysis. *British Medical Journal*, 336(7637):202–205, January 2008.
KEY: LubeEtA12008a
ANNOTATION: OBJECTIVE: Rapid diagnostic tests for malaria seem cost effective in standard analyses, but these do not take account of clinicians' response to test results. This study tested the impact of clinicians' response to rapid diagnostic test or microscopy results on the costs and benefits of testing at different levels of malaria transmission and in different age groups. DESIGN: Cost-benefit analysis using a decision tree model and clinical data on the effectiveness of diagnostic tests for malaria, their costs, and clinicians' response to test results. SETTING: Tanzania. METHODS: Data were obtained from a clinical trial of 2425 patients carried out in three settings of varying transmission. RESULTS: At moderate and low levels of malaria transmission, rapid diagnostic tests were more cost beneficial than microscopy, and both more so than presumptive treatment, but only where response was consistent with test results. At the levels of prescription of antimalarial drugs to patients with negative tests that have been found in observational studies and trials, neither test method is likely to be cost beneficial, incurring costs 10-250% higher, depending on transmission rate, than would have been the case with fully consistent responses to all test results. Microscopy becomes more cost beneficial than rapid diagnostic tests when its sensitivity under operational conditions approaches that of rapid diagnostic tests. CONCLUSIONS: Improving diagnostic methods, including rapid diagnostic tests, can reduce costs and enhance the benefits of effective antimalarial drugs, but only if the consistency of response to test results is also improved. Investing in methods to improve rational response to tests is essential. Economic evaluations of diagnostic tests should take into account whether clinicians' response is consistent with test results.
- [200] M L Luhanga, M J Mwandosya, and P R Luteganya. Optimization in computerized energy modelling for Tanzania. *Energy*, 18(11):1171 – 1179, 1993.
KEY: LuhaEtA11993
ANNOTATION: An overview of energy planning research is presented on implementation of the LEAP model for Tanzania through the use of optimization models in combination with a forecasting program. Two models were developed in the research. The first determines the optimum mix of energy resources at minimum cost. The second seeks the optimum number of end-use biomass devices and hectares of land to be afforested to minimize the woodfuel deficit. The second model was tested using data for Dar es Salaam only. The output of a forecasting program was fed into optimization models the outputs of which were entered into LEAP. The LEAP model is run using optimal and non-optimal inputs for comparison. The results prove the hypothesis that energy planning with the LEAP model is more effective if the model is complemented by optimization models.
- [201] Travis J Lybbert, John G McPeak, Winnie K Luseno, and Christopher B Barrett. Bayesian herders: updating of rainfall beliefs in response to external forecasts. *World Development*, 35(3):480–497, March 2007.
KEY: LybbEtA12007
ANNOTATION: Temporal climate risk weighs heavily on many of the world's poor. Model-based climate forecasts could benefit such populations, provided recipients use forecast information to update climate expectations. We test whether pastoralists in southern Ethiopia and northern Kenya update their expectations in response to forecast information. The minority of herders who received these climate forecasts updated their expectations for below normal rainfall, but not for above normal rainfall. This revealed preoccupation with downside risk highlights the potential value of better climate forecasts in averting drought-related losses, but realizing any welfare gains requires that recipients strategically react to these updated expectations.
- [202] Robert B Mabele. Crop output potentials of peasant farms in Kwimba District, Tanzania: a linear programming analysis. Master's thesis, University of Tennessee, Knoxville, 1974.
KEY: Mabe1974
- [203] Rejoice Mabudafhasi. The role of knowledge management and information sharing in capacity building for sustainable development—an example from South Africa. *Ocean & Coastal Management*, 45(9-10):695 – 707, 2002.
KEY: Mabu2002
ANNOTATION: The coastal areas of the Northern Cape, South Africa, and the transfrontier region with Namibia are in a state of rapid transformation from a mining-based economy to one supporting diverse and sustainable livelihoods. Land-based diamond mining activities are in the

early stages of decommissioning while a number of planning and development initiatives are underway. Key obstacles to integrated planning and development in the region are insufficient and inaccessible information. Knowledge management (KM) and information sharing mechanisms can facilitate meaningful participation and promote decision-making at the local level. The distance learning and information sharing tool is an internet based KM tool that promotes transparency and collaboration and provides open access to information resources for sustainable development.

- [204] Eduardo Eiji Maeda, Barnaby J.F. Clark, Petri Pellikka, and Mika Siljander. Modelling agricultural expansion in Kenya's Eastern Arc Mountains biodiversity hotspot. *Agricultural Systems*, 103(9):609–620, 2010.

KEY: MaedEtAl2010a

ANNOTATION: The Taita Hills are the northernmost part of the Eastern Arc Mountains of Kenya and Tanzania, which is one of the most important regions for biological conservation in the world. The indigenous cloud forests in this area have suffered substantial degradation for several centuries due to agricultural expansion. In the Taita Hills, currently only 1% of the original forested area remains preserved. In order to create effective policies to preserve the natural resources and biodiversity of the Eastern Arc Mountains it is crucial to understand the causes and interactions involved in the landscape changes in the most degraded areas. The research presented here aimed to understand the role of landscape attributes and infrastructure components as driving forces of agricultural expansion in the Taita Hills. Geospatial technology tools and a landscape dynamic simulation model were integrated to identify and evaluate the driving forces of agricultural expansion and simulate future landscape scenarios. The results indicate that, if current trends persist, agricultural areas will occupy roughly 60% of the study area by 2030. Agricultural expansion will likely take place predominantly in lowlands and foothills throughout the next 20 years, increasing the spatial dependence on distance to rivers and other water bodies. The main factors driving the spatial distribution of new croplands were the distance to markets, proximity to already established agricultural areas and distance to roads. Other driving forces of the agricultural expansion, as well as their implications for natural resources conservation, are discussed. Further studies are necessary to integrate the effects of population pressure and climate change on the sustainability and characteristics of local agricultural systems.

- [205] Eduardo Eiji Maeda, Petri K.E. Pellikka, Mika Siljander, and Barnaby J.F. Clark. Potential impacts of agricultural expansion and climate change on soil erosion in the Eastern Arc Mountains of Kenya. *Geomorphology*, 123(3-4):279–289, 2010.

KEY: MaedEtAl2010b

ANNOTATION: The Taita Hills form the northernmost part of the Eastern Arc Mountains of Kenya and Tanzania, is one of the world's most important regions for biological conservation. Due to the expansion of agricultural activities during the last centuries, currently only 1% of the original vegetation remains preserved in the Taita Hills. These landscape changes, together with potential increases in rainfall volumes caused by climate change, offer a great risk for soil conservation. The present research aims to evaluate how future changes in climate and land use can alter, in time and space, the variables inherent to a widely used soil erosion model, and to assess the impacts of these changes for soil conservation. A modelling framework was assembled by integrating a landscape dynamic model, a soil erosion model and synthetic precipitation datasets generated through a Monte Carlo simulation. The results indicate that, if the current trends persist, agricultural areas will occupy roughly 60% of the study area by 2030. Although these land use changes will certainly increase soil erosion figures, new croplands will likely take place predominantly in the lowlands, which comprises areas with lower soil erosion potential. By the year 2030, rainfall erosivity is likely to increase during April and November, while a slight decrease tendency is observed during March and May. An integrated assessment of these environmental changes, performed using the modelling framework, allows a clear distinction of priority regions for soil conservation policies during the next 20 years.

- [206] Stefano Mainardi. Cropland use, yields, and droughts: spatial data modeling for Burkina Faso and Niger. *Agricultural Economics*, 42(1):17–33, 2011. publisher: Blackwell Publishing Inc; ISSN: 1574-0862; also available as: [//dx.doi.org/10.1111/j.1574-0862.2010.00465.x](https://doi.org/10.1111/j.1574-0862.2010.00465.x).

KEY: Main2011

ANNOTATION: Abstract For countries with recurrent droughts, the design of drought impact mitigation measures could benefit from analyses of determinants of yields and prices of local crops at regional and district level. This study applies dynamic spatial panel data regression models to yields and prices of four major food crops across regions of Burkina Faso and Niger, over sample periods between 1984 and 2006. Results lend support to mainly simultaneous spatial spillovers,

particularly for millet and cowpea prices and sorghum yields in Niger, and maize yields in Burkina Faso. After accounting for these effects, most crop yields are found to be weakly price-responsive, as envisaged by a supply-side geographical diffusion hypothesis. Seasonal rainfall elasticity estimates suggest that dominant food crops have slight advantage margins in terms of relative resilience to rainfall shortages. However, this result is to be weighed against low millet yields in Niger, and marked drops in sorghum yields during officially declared droughts in Burkina Faso.

- [207] Emmanuel Agapitus Manday. *An analysis of resource use in a maize-legume farming system in Kilosa District, Tanzania*. PhD thesis, University of Illinois at Urbana–Champaign, USA, 1982.

KEY: Mand1982

- [208] Emmanuel Manzungu. More than a headcount: towards stakeholder representation in catchment management in South Africa and Zimbabwe. *Physics and Chemistry of the Earth*, 27:927–933, 2002.

KEY: Manz2002

ANNOTATION: In 1998 both South Africa and Zimbabwe promulgated new water laws to ensure that ownership and usership patterns of water resources match the new socio-political order. Integrated water resource management, incorporating among other things decentralized and democratized water management institutions and the principles of stakeholder participation, was regarded as the cornerstone of the reforms. This article examines how stakeholder representation, particularly of the formerly disadvantaged people, has been handled. It is observed that there has been too much effort dedicated to ensure a mere headcount of the stakeholders at the water table rather than on strategic representation. Strategic representation emphasizes stakeholder identity instead of consensus. Selective alliance building is important as is establishing genuine local level platforms with enough political space outside the state-tailored formal straight jackets. It is equally important to address developmental aspects of establishing catchment-wide bodies and structural problems such as access to land and financial resources. Without addressing these issues stakeholder representation will remain hamstrung in good intentions.

- [209] A M Mapapa. Management of railways in sub-Saharan Africa. *Rail International*, 35:13–21, 2004.

KEY: Mapa2004

ANNOTATION: The technical performance and productivity gains of railway companies in Sub-Saharan Africa were analyzed. Two methods were applied for the study of the figures and data collected on the African railway companies. The DEA method (Data Envelopment Analysis) was used to identify best management practice. The second method, Malmquist quantity index, measures the total factor productivity of a particular business sector and the firms in that sector, and enables the sources of growth to be identified according to the criteria of enhanced efficiency and technological change. The African railways in the study were found to be inefficient in productive terms with an overall mean efficiency rate of 77%, which is due to poorly used resources for production.

- [210] F Masiye. Investigating health system performance: An application of data envelopment analysis to Zambian hospitals. *BMC Health Services Research*, 7:11 pages, accessed 26:October:2010, 2007.

KEY: Masi2007

ANNOTATION: Background: Zambia has recently articulated an ambitious national health program designed to meeting health-related MDGs. Public expectations are high and Zambia continues to receive significant resources from global and bilateral donors to support its health agenda. Although the lack of adequate resources presents the most important constraint, the efficiency with which available resources are being utilised is another challenge that cannot be overlooked. Inefficiency in producing health care undermines the service coverage potential of the health system. This paper estimates the technical efficiency of a sample of hospitals in Zambia. Methods: Efficiency is measured using a DEA model. Vectors of hospital inputs and outputs, representing hospital expended resources and output profiles respectively, were specified and measured. The data were gathered from a sample of 30 hospitals throughout Zambia. The model estimates an efficiency score for each hospital. A decomposition of technical efficiency into scale and congestion is also provided. Results: Results show that overall Zambian hospitals are operating at 67% level of efficiency, implying that significant resources are being wasted. Only 40% of hospitals were efficient in relative terms. The study further reveals that the size of hospitals is a major source of inefficiency. Input congestion is also found to be a source of hospital inefficiency. Conclusion: This study has demonstrated that inefficiency of resource use in hospitals is significant. Policy attention is drawn to unsuitable hospital scale of operation and low productivity of some inputs as factors that reinforce each other to make Zambian hospitals technically inefficient at producing and delivering services.

It is argued that such evidence of substantial inefficiency would undermine Zambia's prospects of achieving its health goals.

- [211] M K Masozera, J R R Alavalapati, S K Jacobson, and R K Shrestha. Assessing the suitability of community-based management for the Nyungwe Forest Reserve, Rwanda. *Forest Policy and Economics*, 8:206–216, 2006.

KEY: MazoEtAl2006

ANNOTATION: This study assesses the perceptions of representatives from three stakeholder groups—local communities, a government agency, and an environmental organization—towards the suitability of community-based management (CBM) approach to the Nyungwe Forest Reserve, Rwanda. A strengths, weaknesses, opportunities, and threats (SWOT) technique in combination with an analytic hierarchy process was used to achieve the task. Results show that representatives of local communities perceive positive aspects of CBM outweigh its negative aspects. However, representatives of a government agency and a nongovernmental organization anticipate that weaknesses associated with CBM approach outweigh its strengths. Our analyses show that stakeholder groups view CBM differently, suggesting a need for better understanding about this approach. Implementation of CBM in small scales first along with outreach activities might bring stakeholders together and will ensure conservation and rural community stability.

- [212] B H Massam, R Akhtar, and I D Askew. Applying operations research to health planning: Locating health centres in Zambia. *Health Policy and Planning*, 1:326–334, 1986.

KEY: MassEtAl1986

ANNOTATION: Accessibility to health care facilities, particularly in rural areas with dispersed populations, is a major concern of primary health care policies. The physical accessibility of rural health care facilities is often assessed in terms of their location relative to those who will use them. However, the final choice of location for a facility will often depend on a trade-off between many criteria including not only its physical accessibility for the users, but also its costs to the provider, its political value to local leaders, etc. In this paper a technique will be presented which can help health policy-makers and planners in deciding on the optimum location for rural health facilities by taking into account the different criteria of these various interest groups. The technique is intended to help in a prospective evaluation of alternative feasible locations; it is therefore appropriate for operations research. Two examples are taken from Zambia to illustrate how the approach could be used in choosing the most suitable location for upgrading a rural health centre in a district.

- [213] Rubhera R A M Mato and T S Mufuruki. Noise pollution associated with the operation of the Dar es Salaam International Airport. *Transportation Research D*, 4D(2):81–89, March 1999.

KEY: MatoMufu1999

ANNOTATION: The operation of airports results in environmental impacts associated with high levels of noise and vibrations. These may have severe negative effects to both workers and surrounding residents and their properties. Here we look at the noise impacts associated with the operation of the Dar es Salaam International Airport in Tanzania. Field measurements were carried out to determine noise levels at various positions at the airport during aircraft landing and take-off. The surrounding residents' perceptions on the noise were also investigated using semi-structured interviews. Workers on the apron (marshellers), house keepers, security workers, and mechanics are exposed to noise levels that could affect their health. The noise levels in the surrounding settlements of Kipawa and Kiwalani were higher than the WHO recommended limits and causing annoyance to residents. The use of appropriate ear protectors by the workers was found to reduce the noises to harmless levels. Periodical audiometric tests of the workers will help to monitor the noise impacts. Enforcement of appropriate environmental regulations on the airlines can also reduce noise pollution at the airport.

- [214] M Mbangala and S Perelman. Technical efficiency of African sub-Saharan railways companies: an international comparative analysis using DEA [L'efficacite technique des chemins de fer en Afrique subsaharienne: une comparaison internationale par la methode de DEA]. *Revue d'Economie du Developpement*, 97:91–115, 1997.

KEY: MbanPere1997

ANNOTATION: In this paper we estimate technical efficiency for nine railways companies operating in the African Sub-Saharan countries using a non parametric frontier approach: DEA. We show that over the 1975–1990 period, some companies had great difficulties to improve, and even to maintain, their technical efficiency scores. Furthermore, a statistical analysis allows use to identify some explanatory factors of technical efficiency. Among them, it appears that firms that favored passenger transportation over the last decades experienced also the best results.

- [215] Chola Kasoma Mbilima. Water supply and sanitation in Zambia: reform and regulation. *Municipal Engineer*, 161(4):255–261, December 2008.

KEY: Mbil2008

ANNOTATION: Zambia has undertaken water sector reforms over the past decade. The introduction of an autonomous water supply and sanitation regulator, National Water Supply and Sanitation Council, has provided a new institution with tools for improving sector performance. As with any reform, citizen confidence with new arrangements will depend on their perceptions of sector improvements, including water quality and network expansion. This study shows that performance monitoring (and associated rewards) has begun to have a positive impact, although much remains to be done.

- [216] S J McCarthy. Potential applications of O.R. in developing countries – a generalization from Botswana. *Journal of the Operational Research Society*, 29(2):167–170, February 1978.

KEY: McCa1978

ANNOTATION: Generalizing from experience in Botswana, the paper considers the role which O.R. can play in the development process in developing countries. It is argued that sophisticated techniques on tactical problems are unlikely to repay the research cost involved, while whole economy models, although interesting, are not operational. Nevertheless, O.R. could contribute to development by building various types of simple logical models, to demonstrate logical relations, and to serve in untangling decision options.

- [217] B D McIntyre, D R Bouldin, G H Urey, and F Kizito. Modeling cropping strategies to improve human nutrition in Uganda. *Agricultural Systems*, 67(2):105–120, 2001.

KEY: McInEtA12001

ANNOTATION: This paper contrasts two Ugandan cropping systems, a banana-based (*Musa AAA*) and a grain-based (*Zea mays* and *Sorghum bicolor*), and focuses on the potential of each to provide food in sufficient quantity to meet household nutritional requirements. The objectives of this study were to estimate the amount of energy, protein, vitamin A, Ca, Fe and Zn furnished by these two systems; and to model cropping strategies capable of improving nutritional output given the same land area and location. Results show that both systems currently fail to satisfy a range of nutritional needs with Zn and Ca deficits being the most extreme. Modifications in cropping strategies explored through modeling showed that improved nutrition in both systems was possible given the same resource base. Improved nutrition in the banana-cropping system requires major changes in the allocation of land: e.g. a two-thirds reduction in the proportion of land devoted to banana. Adequate nutrition given the same resource base would require the incorporation of several species (e.g. *Amaranthus lividus* and *Glycine max*), which though present are uncommon. Though we suggest changes in extant cropping systems, this paper acknowledges that such changes would occur in the context of practices embedded in cultural norms.

- [218] A D McLaren. *An economic study of farm development in Botswana's traditional sector*. PhD thesis, University of Aberdeen, UK, 1979.

KEY: Mcla1979

ANNOTATION: The initial part of this thesis describes the geography of Botswana, and the country's historical and political background. The economy is described and compared with various theories of economic development. An account is given of the economic importance of agriculture, illustrating that although agriculture's share of gross domestic product is falling, over 80% of the country's population still relies heavily on farming, and will continue to do so for the foreseeable future. Agriculture, however, is basically a subsistence activity, and must be greatly improved if the country is to be self sufficient in food, and if the traditional sector is to absorb most of the growing labour force. Farm management studies can help devise more appropriate development of agriculture, and one technique—linear programming—was chosen to suggest answers to some of the farming problems in Botswana. The linear programming study showed a number of implications for farm size, labour requirements and cropping pattern, and indicated a number of constraints which would limit farmers' adoption of improved farming methods. Most important of these constraints seemed to be capital. The findings suggested various implications for government policies, and these are discussed at some length. Increased capital availability, or reduced riskiness of farming, seemed to be essential for better farming. Further areas for research are suggested in order to make the linear programming model more accurate in its representation of farmers' behaviour. In conclusion, it is suggested that linear programming, especially if improved beyond the scope of this study, can be a useful tool for farm management, which itself can play a vital role in the development of agriculture, and hence in the overall development of the country.

- [219] D E McMillan and M I Meltzer. Vector-borne disease control in sub-Saharan Africa: A necessary but partial vision of development. *World Development*, 24(3):569–588, 1996.

KEY: McMiMelt1996

ANNOTATION: A comparative analysis of efforts to control four major vector-borne diseases that plague agricultural development in sub-Saharan Africa — *onchocerciasis* (river blindness), bovine *trypanosomiasis*, malaria, and East Coast Fever — reveals numerous similarities in the technical reasons why control programs break down. The authors conclude that there is an urgent need to develop simpler control technologies and to pay more attention to the types of socioeconomic planning (including land-use planning) that must accompany or predate disease control efforts if they are to fulfill their full economic and social potential over time.

- [220] A S M Mgeni and C Price. Planning of forest plantation investments with the aid of linear programming: A case study of Sao Hill Forest, Tanzania. *Forest Ecology and Management*, 62(1-4):51-72, 1993.

KEY: MgenPric1993

ANNOTATION: Tanzania has adopted central planning. Since the realisation of the development strategy is essentially propelled by micro-level decisions, quantitative micro-planning is imperative. The feasibility of designing a planning scenario for forest projects along this locus is illustrated by a case study of Sao Hill Forest Project — the largest state-owned industrial plantation with 45,000 ha planted by 1990 of pines and eucalypts, supporting both a sawmill and an integrated pulp and paper mill. Planting activities include both afforestation and reforestation. Land evaluation is effected as a combination of biophysiological approach and social cost-benefit analysis. Constrained by resource availability, the optimal combination of planting activities in a given year is determined using linear programming. This planning scenario is technically feasible. The smallest land unit studied is called a *land element* which is the simplest component of the landscape which for practical purposes is uniform in lithology, form, soil and vegetation. A stratum of similar elements is called a 'land facet'. Since the profitability of planting at Sao Hill partly depends on the species grown, site productivity, land preparation involved, terrain types and the forest products to be produced, the land elements are redefined as a function of these factors. All the plantable sites or land elements available in year 1984/1985 were inventoried covering 37,310 ha grouped into 62 land facets. Each land facet was identified as an independent forest plantation investment project. The resource demand for each operation on each land facet was gathered from the project management including costings. Financial cash flow was generated followed by shadow pricing, essentially based on the procedure of Little and Mirrlees and its variants. Land expectation value (LEV) was applied in evaluating land facets at financial, economic and social prices. All land facets had positive LEVs, implying that it was worth planting each land facet. Constrained by several resources, it is infeasible to undertake all technically feasible and economically desirable planting activities within the first plan period. Linear programming was found to be useful in solving this decision problem. The solution to the Sao Hill planting problem is given in terms of the number of hectares scheduled for planting between 1984/1985 and 1988/1989 inclusive, embodying the value of the objective function and the shadow prices of the binding constraints. The information generated is very useful to decision-makers and project management.

- [221] E Michael, D W Meyrowitsch, and P E Simonsen. Cost and cost effectiveness of mass *diethylcarbamazine* chemotherapy for the control of *bancroftian filariasis*: Comparison of four strategies in Tanzania. *Tropical Medicine and International Health*, 1(4):414-426, 1996.

KEY: MichEtAl1996

ANNOTATION: This study examines the costs and cost effectiveness of four different mass diethylcarbamazine (DEC) chemotherapy regimens — standard dose, semi-annual single dose, low monthly dose and DEC-medicated salt — in reducing microfilarial (mf) prevalence at the community level. Costs were estimated for each intervention in relation to both ingredient and activity, by the derivation and use of detailed itemized cost menus. The most expensive and most effective strategy in reducing community mf prevalence over 2 years was DEC salt intervention, followed in order of costs by the standard, low monthly and semi-annual DEC strategies. The most cost effective strategy was the low monthly DEC treatment. Cost and sensitivity analyses, however, suggest that the optimal choice of mass DEC strategy for reducing mf is very sensitive to programme design parameters. In particular, the results demonstrate that if the salt delivery structure is simplified, DEC salt has the potential to be the dominant intervention for filariasis control. The results suggest that economies of scale considerations might militate against the adoption of this intervention for large-scale applications, unless perhaps offset by its potential for cost recovery by direct patient purchase. Further analyses require a more realistic evaluation of filariasis intervention effectiveness by addressing changes in infection intensity and by accounting for the population dynamics of parasite transmission and control.

- [222] Katharina Michaelowa. Primary education quality in Francophone sub-Saharan Africa: Determinants of learning achievement and efficiency considerations. *World Development*, 29(10):1699–1716, October 2001.
 KEY: Mich2001
 ANNOTATION: What are the most efficient means to ensure basic learning competencies for a high number of children? This question is analyzed on the basis of the exceptionally rich data set provided by the ‘Program on the Analysis of Education Systems’ (PASEC), standardized and comparable for the five countries Burkina Faso, Cameroon, Côte d’Ivoire, Madagascar and Senegal. A Hierarchical Linear Model is used to assess the individual, school level, and national characteristics determining fifth-grade students’ achievement in French and mathematics. Special consideration is given to institutional factors. A further question addressed is the possibility of a tradeoff between enrolment and education quality.
- [223] M C Milanzi. The development of critical systems thinking in Tanzania. *Systems Research*, 12(4):313–317, 1995.
 KEY: Mila1995
 ANNOTATION:
- [224] K Miles, D J Clutterbuck, O Seitio, M Sebege, and A Riley. Antiretroviral treatment roll-out in a resource-constrained setting: capitalizing on nursing resources in Botswana. *Bulletin of the World Health Organisation*, 85(7):555–560, July 2007.
 KEY: MileEtAl2007
 ANNOTATION: PROBLEM: As programmes to deliver antiretroviral therapy (ART) are implemented in resource-constrained settings, the problem becomes not how these programmes are going to be financed but who will be responsible for delivering and sustaining them. APPROACH: Physician-led models of HIV treatment and care that have evolved in industrialized countries are not replicable in settings with a high prevalence of HIV infection and limited access to medical staff. Therefore, models of care need to make better use of available human resources. LOCAL SETTING: Using Botswana as an example, we discuss how nurses are underutilized in long-term clinical management of patients requiring ART. RELEVANT CHANGES: We argue that for ART-delivery programmes to be sustainable, nurses will need to provide a level of clinical care for patients receiving this therapy, including prescribing ART and managing common adverse effects. LESSONS LEARNED: Practicalities involved in scaling up nurse-led models of ART delivery include overcoming political and professional barriers, identifying educational requirements, agreeing on the limitations of nursing practice, developing clear referral pathways between medical and nursing personnel, and developing mechanisms to monitor and supervise practice. Operational research is required to demonstrate that such models are safe, effective and sustainable.
- [225] Bart Minten and Steven Kyle. The effect of distance and road quality on food collection, marketing margins, and traders’ wages: evidence from the former Zaire. *Journal of Development Economics*, 60(2):467 – 495, 1999.
 KEY: MintKyle1999
 ANNOTATION: Food price variation is typical of the food economies of many low income countries. The presence or absence of road infrastructure is perceived to be one of the main determinants of this variation. This analysis shows that in the case of the former Zaire, food price dispersion is significant both across products and across regions. It is demonstrated that transportation costs explain most of the differences in food prices between producer regions and that road quality is an important factor in the transportation costs. However, food prices decrease relatively faster than transportation costs increase and traders’ wages are higher on bad roads.
- [226] G Mmopelwa. Economic and financial analysis of harvesting and utilization of river reed in the Okavango Delta, Botswana. *Journal of Environmental Management*, 79(4):329 – 335, 2006.
 KEY: Mmop2006
 ANNOTATION: The Okavango Delta, the largest Ramsar wetland site, is one of the most resource-rich ecosystems in Botswana. A range of resources, including reeds, contribute in various ways to the well-being of many of the communities through subsistence and income generation. The economic value of reeds and other resources found in wetlands has been poorly understood, leading to the perception that wetlands are wastelands, and have little or no economic values. Such resources are therefore likely to receive lower priority in conservation when evaluated against other alternative activities. The aim of this research was to determine the benefit and financial and economic viability of harvesting river reed in the Okavango Delta. Primary data were collected through a structured questionnaire administered at three villages in the Okavango Delta. Secondary data were collected from existing literature. Financial and economic analysis was undertaken using static and financial models. Market prices were used to calculate the net income generated from the sale of harvested reed. The measurement criteria for static models were the annual net cash

income, net annual economic benefit, and return on investment (ROI), while those under the dynamic models were the net present value (NPV), benefit cost ratio (BCR), and the net benefit investment (N/K) ratio. It was more financially profitable and economically viable to harvest and sell reeds at Shorobe village (a village relatively close to the District economic centre, Maun), than Shakawe or Etsha-13.

- [227] Freddy Moens. Design, implementation, and evaluation of a community financing scheme for hospital care in developing countries: A pre-paid health plan in the Bwamanda health zone, Zaire. *Social Science & Medicine*, 30(12):1319 – 1327, 1990.

KEY: Moen1990

ANNOTATION: Unless scarce resources can be mobilized and used efficiently, health for all by the year 2000 will remain a vain attempt. Innovative financing schemes exploring increased cost recovery from the users of the health system are explored throughout the world. In Bwamanda, Zaire, a community financing scheme for hospital care was developed through the application of operations research. A preference heuristic with considerable involvement of health providers and the community was used to identify the type of financing scheme and resulted in a pre-paid health plan, while a mathematical model was developed to determine the premiums to charge. The implementation of the health plant is briefly described. An evaluation of the effects of the pre-paid plan on the accessibility and equity of health care, as well as on the financial sustainability of the hospital, is presented and discussed: a steadily increasing membership of the health plan illustrates its appropriateness, while a doubling of the cost recovery of the hospital's operating costs after two years seems promising; the hospitalization rate of members of the health plan was significantly higher than for non-members. These findings suggest that a health zone may be an appropriate level for the organization of a regional pre-paid health plan. Problems of equity, full cost recovery, and replicability of the financing scheme are discussed.

- [228] Gerald C Monela and Birger Solberg. *Deforestation and Agricultural Expansion in Mhonda area, Tanzania*, chapter 4, pages 183–194. Kluwer, 2000.

KEY: MoneSolb2000

ANNOTATION: This paper analyzes the possibilities for sustainable land use management at farm level in order to preserve the tropical rainforest in the Nguru mountains in Tanzania. Based on data collected in Mhonda area, a compromise programming model at household farm level was developed and used to analyze deforestation as a consequence of population growth, working capital availability, crop prices, fertilizer costs and risk aversion of the farmers. The study showed that existing farming systems can sustain the present population growth rate of 3.7% per year for only a maximum duration of between 10 and 15 years. Forest encroachment for agriculture is one main agent of deforestation pressure. Declining crop productivity and income under risk conditions, and growing food demand due to population growth are key driving forces for encroachment. The existing farm activities can be improved to reduce deforestation pressure by resource re-allocation and risk management in the short term and introducing more appropriate farming technology in the long term. Improving household economy is also crucial to raise farmer's income, and improve land use practices to reduce deforestation pressure.

- [229] Maxwell Mudhara and Peter E Hildebrand. Assessment of constraints to the adoption of improved fallows in Zimbabwe using linear programming models. In Janaki R R Alavalapati and D Evan Mercer, editors, *Valuing Agroforestry Systems: Methods and Applications*, number 2 in *Advances in Agroforestry*, pages 201–218. Kluwer, 2004.

KEY: MudhHild2004

- [230] Maxwell Mudhara, Peter E Hilderbrand, and P K R Nair. Potential for adoption of *Sesbania sesban* improved fallows in Zimbabwe: A linear programming-based case study of small-scale farmers. *Agroforestry Systems*, 59(3):307–315, November 2003.

KEY: MudhEtAl2003

ANNOTATION: Farmers' adoption of improved technologies is the ultimate measure of the success of any agricultural innovation. In a joint project of the International Centre for Research in Agroforestry (ICRAF) and the Department of Research and Specialist Services of Zimbabwe, the potential for adoption of the improved planted fallow technology using *Sesbania sesban* was assessed in the Mangwende Communal Area. The study was based on experimental data of maize (*Zea mays*) yields following 1-, 2- and 3-year improved fallows at Domboshawa Training Center, northern Zimbabwe where the improved fallows were promising. The data indicated that maize yields were higher after *S. sesban* fallows than after *Cajanus cajan* and *Acacia angustissima* fallows. A five-year linear programming model sensitive to the diversity within households was developed to simulate the livelihood system of households in the Mangwende Communal Area. Improved fallows

of *S. sesban* were incorporated into the model to determine the potential for their adoption. Model results indicated that there is potential for the technology to be adopted by 80% of the farmers. According to the model, the new technology on average occupies 60% of the area under maize. Nevertheless, households continue to use fertilizers and cattle manure. One-year improved fallows are planted every other year; three-year improved fallows are also planted. Farmers who adopt the fallow technologies realize an increase in the cash available for discretionary spending. actors such as composition of the household in terms of fulltime workers, size of the arable land owned by the farmer, and whether the household differentiates activities by gender, determine the adoption of the improved-fallow technology.

- [231] Richard Mulwa, Ali Emrouznejad, and Lutta Muhammad. Economic efficiency of smallholder maize producers in Western Kenya: a DEA meta-frontier analysis. *International Journal of Operational Research*, 4(3):250–267, 2009.
KEY: MulwEtAl2009
ANNOTATION: Maize is the main staple food for most Kenyan households, and it predominates where smallholder, as well as large-scale, farming takes place. In the sugarcane growing areas of Western Kenya, there is pressure on farmers on whether to grow food crops, or grow sugarcane, which is the main cash crop. Further, with small and diminishing land sizes, the question of productivity and efficiency, both for cash and food crops is of great importance. This paper, therefore, uses a two-step estimation technique (DEA meta-frontier and Tobit Regression) to highlight the inefficiencies in maize cultivation, and their causes in Western Kenya.
- [232] Richard Mulwa, Ernst-August Nuppenau, and Ali Emrouznejad. Productivity growth in smallholder sugarcane farming in Kenya: A Malmquist TFP decomposition. In *Online access to Deutscher Tropentag (2005)*, Deutscher Tropentag, page 6. Deutscher Tropentag, Deutscher Tropentag, 2005.
KEY: MulwEtAl2005
ANNOTATION: An effective economic development strategy depends critically on promoting productivity and output growth in the agricultural sector, particularly among small-scale producers (SSP). The percentage market share of SSP output in Kenya has risen from slightly over 56% in 1990 to 70% in 2001 (Economic survey, 2001). In cane areas, they represent 90% of the total cane surface area. Cane yields in the last 10 years have been on a declining trend. The study aims at determining total factor productivity and decomposing it to efficiency and technological components, to determine source of decline.
- [233] B W Murck, C M Dufournaud, and J B R Whitney. Simulation of policy aimed at the reduction of wood use in the Sudan. *Environment & Planning A*, 17(9):1231–1242, 1985.
KEY: MurcEtAl1985
ANNOTATION: A rectangular economic input-output table for the Sudan is presented, based on 9 sectors, 37 commodities, 6 primary inputs, and 7 final demand categories. Four possible models of intermediate consumption are derived by using linear programming and entropy maximizing. The table is then linked to a coefficient representing wood use per unit of output in the Sudanese economy. A policy aimed at a reduction in wood use is tested by simulating the introduction of more efficient charcoal stoves into urban households. Implementation of the policy would lead to a significant reduction in total wood used. Reallocation of the resulting savings by households into energy-intensive commodities, however, reduces the effectiveness of the policy by as much as 48%.
- [234] Maina G Muriithi. Optimal power flow for the high voltage network of the Kenya power system. *IEEE AFRICON Conference*, 1:162–168., 1996.
KEY: Muri1996
ANNOTATION: Economy and reliability of service are important considerations in power system operation and planning. These two aspects of a power system can be adequately satisfied by formulating a suitable optimal power flow problem and finding an appropriate solution methodology. The solution to an optimal power flow problem locates a feasible operating point that gives the least value of a desired objective parameter (e.g. fuel cost, real power loss) subject to satisfying system constraints like voltage levels, real and reactive power flow on transmission lines and transformer tap settings. A suitable optimal power flow solution thus ensures an economical and secure operating point. The solution can be obtained using several non-linear programming techniques which include the steepest descent method, Quadratic Programming Method (QPM) and the Gradient Projection Method (GPM) among others. In this paper, the optimization problem is solved using the steepest descent method and targets the Kenya Power System.
- [235] K S R Murthy and Abiy Gatachew Mamo. Multi-criteria decision evaluation in groundwater zones identification in Moyale-Teltele subbasin, South Ethiopia. *International Journal of Remote Sensing*, 30(11):2729–2740, 2009.

KEY: MurtMamo2009

ANNOTATION: The conventional approaches such as ground-based surveys and exploratory drilling for groundwater investigation are time-consuming and uneconomical. Systematic organisation of data of characteristics of any terrain, evaluation of inter-thematic, interclass dependencies and variability, and also analysing cumulative effect on the development of groundwater regime is the best approach which the current decade requires. This is proved by generation of the thematic information on the above factors through remote sensing technique, and integration in geographic information system (GIS) for evaluation using multi-criteria decision-making techniques. This paper presents the results of the attempt made to identify the groundwater potential zones in the Moyale-Teltele Sub basin of the Genale Dawa River Basin in South Ethiopia using the integrated approaches of remote sensing and geographic information systems. Six geologic, physiographic, and hydrologic factors were applied namely: lithology, structure, geomorphology, slope, land cover, and drainage. Weighted Overlay Analysis using multicriteria decision technique is implemented to produce the groundwater potential map of the area. This result is further verified by groundwater yield data of boreholes and springs collected in the field and from previous reports. The validation revealed that the result is in good conformity with the actual yield of the wells and springs.

- [236] Gladys Mutangadura and George W Norton. Agricultural research priority setting under multiple objectives: an example from Zimbabwe. *Agricultural Economics*, 20(3):277–286, May 1999.

KEY: MutaNort1999

- [237] Jeniffer Mutiga, Shadrack Mavengano, Su Zhongbo, Tsehaie Woldai, and Robert Becht. Water allocation as a planning tool to minimise water use conflicts in the Upper Ewaso Ngiro North Basin, Kenya. *Water Resources Management*, 24:3939–3959, 2010. 10.1007/s11269-010-9641-9.

KEY: MutiEtAl2010

ANNOTATION: Inadequate water resources management and a general decline in rainfall have aggravated water scarcity problems in the Upper Ewaso Ngiro North Basin in Kenya. Furthermore, water use conflicts in the basin have escalated in recent decades due to increased competition for available water resources. Excessive abstraction of the declining river water mainly for irrigation in the Mount Kenya and Nyandarua foot zones often leads to reduced water flow during the dry seasons, greatly affecting downstream water users. Increased water use in the basin coupled with deterioration of the vegetative cover has resulted in reduced water flows in the Ewaso Ngiro river and its major tributaries. In addition, lack of sufficient knowledge about available water resources and current lack of coordination in water resources management in the basin often result in water deficits which have hampered development in the downstream catchment. The goal of this study was to match the water requirements of various competing sectors in the basin with the available water resources in order to attain both economic and ecological sustainability. To achieve this, GIS techniques were used to quantify the spatial and temporal stream flow. The Water Evaluation and Planning (WEAP) model was applied to evaluate water resources development based on an equilibrium scenario of the current water demand. Water use was simulated for five different sectors (domestic, livestock, wildlife, irrigation and reserve). The analyses revealed that high water demand for irrigation was the main cause of excessive water abstraction particularly in the upstream catchments, giving rise to water shortages and consequently, water use conflicts downstream. The study, therefore, recommends that rainwater harvesting be promoted in the basin in order to improve water availability for productive use.

- [238] Germano Mwabu, Joseph Wangombe, and Benjamin Nganda. The demand for medical care in Kenya. *African Development Review*, 15(2–3):439–453, 2003.

KEY: MwabEtAl2003

ANNOTATION: We use a quantile regression method to analyse the demand effects of user fees over the entire distribution of visits in a sample of rural and urban populations controlling for other covariates of interest, notably income and demographics. We find that the negative effects of fees on attendance differ across the visit quantiles, with the smallest effects being felt at higher quantiles. The main contribution of the paper is to show the non-uniform effects of fees at different points of the visits distribution, in contrast to the average effect computed using the OLS method. The policy implications of the findings are briefly discussed.

- [239] N S Mwakabuta and A L Kyaruzi. Short-term scheduling of a hydro-thermal system using linear programming technique. In *IPEC 2003 - 6th International Power Engineering Conference*, number P2115 in IPEC, pages 731–736, 2003.

KEY: MwakKyar2003

ANNOTATION: In this paper a short-term Hydrothermal generation scheduling for Tanzania Electricity Supply Company Power System has been presented. The problem is to determine on hourly interval the Hydro and Thermal generation. The scheduling keeps balance between production and consumption in a reliable and economical way during the study period. Linear programming (LP) mathematical model using MATLAB has been developed. The constraints are hydrological balance, thermal power plants limitations and load requirements. The result from LP solution gave low operation cost. Generation was mainly from hydro and all reservoirs elevation was high at the end of planning period.

- [240] N S Mwakabuta and A L Kyaruzi. Optimal generation of electricity from a hydro based system; an experience with thermal independent power producers. In *7th International Power Engineering Conference, IPEC2005*, number 1627359 in IPEC, 2005.

KEY: MwakKyar2005

ANNOTATION: A two stage optimal generation scheduling for Tanzania Electricity Supply Company (TANESCO) System has been presented. The first stage determines the Hydro generation and the second stage optimizes the Thermal generation including two Independent Power Producers (IPPs) to compliment the hydro generation if necessary. The scheduling keeps balance between production and consumption in a more reliable and economical way. Linear programming mathematical model using MATLAB has been developed and used to optimize the generation schedule of the system. The constraints include hydrological balance; thermal power plants limitations, special conditions agreed with IPPs and load requirements. The Linear Programming solution gave schedule with least operation costs as the generation is mainly from hydropower plants at the same time the water levels in all reservoirs are always highly conserved.

- [241] Ngila Mwase. Road project appraisal in Tanzania: A review of the working figures. *Transportation Research A*, 22A(6):395–403, November 1988.

KEY: Mwas1988

ANNOTATION: This paper examines the project appraisal methodology and working figures of road studies in Tanzania. The latter are geared at establishing some broad ‘standard’ guides in road project selection and evaluation. The commonly used appraisal tools such as rates of discount, the time horizon, the multipliers and shadow prices of foreign exchange and labour are examined, as well as the rationale of practitioner’s rules of thumb in this regard. Cost-benefit analysis could, it is argued, be supplemented by peoples’ participation and public accountability of road planners in setting road priorities. This could check parochialism in road provision and ensure the most ‘cost-effective’ road provision and use.

- [242] Kenneth Kaoma Mwenda and Gerry Nkombo Muuka. Towards best practices for micro-finance institutional engagement in African rural areas: selected cases and agenda for action. *International Journal of Social Economics*, 31(1–2):143–158, January 2004.

KEY: MwenMuuk2004

ANNOTATION: Micro-finance institutions are critical to Africa’s quest for solutions to the continent’s development challenge. The area of their greatest potential impact, rural Africa, is not only home to the bulk of the continent’s population, but also the vast majority of Africa’s poor. This paper not only defines MFIs with examples from Zambia, South Africa, Mali and Zimbabwe, it also establishes a clear link between MFIs and both poverty eradication and the empowerment and equality of women, two of the major Millennium Development Goals. The paper concludes with some policy recommendations and a set of ‘best practices’ for the future success of MFIs on the continent, including the need to ensure flexibility and careful government regulation and supervision of MFIs.

- [243] J Namaalwa, P L Sankhayan, and O Hofstad. A dynamic bio-economic model for analyzing deforestation and degradation: An application to woodlands in Uganda. *Forest Policy and Economics*, 9(5):479–495, 2007.

KEY: NamaEtAl2007

ANNOTATION: This study is an effort at developing a dynamic non-linear programming bio-economic model capable of analyzing deforestation and degradation processes in the Ugandan woodlands. The model is unique in capturing the entire systems behavior affecting deforestation and degradation, approximated through changes in forest area and stand density. Thus the model incorporates biological factors, such as growth, the socio-economic factors and related interactions between them. A matrix growth sub-model for the woodlands, accounting for diameter increment, mortality, recruitment and harvest of trees, was imbedded in the overall model to account for the stock

changes over the planning horizon. The socio-economic factors and relations affecting the woodland deforestation and degradation processes are addressed through incorporation of three sets of activities, namely, crop cultivation, livestock raising and wood harvesting for firewood and charcoal. Demand and supply relations for these activities are linked through behavioral, structural and accounting equations. The production, consumption, and sale decisions are assumed to be made simultaneously by the households. Though, the model can be successfully used at different levels and planning horizons, a village is the decision making unit over the period 2003-2020 for the purpose of this study. The net present value of cash flows is taken as a proxy measure for utility that is sought to be maximized under six alternate scenarios, including the base scenario. Under the base scenario, 46.7% woodland clearing for cultivation and 42.1% reduction in biomass density were observed over the model planning horizon. Under the scenarios with improved agricultural yields and increased charcoal prices and taxes, the clearing of available woodland was predicted at 98.3%. Biomass density was observed to decline by about 11.9% and 15.5% with the imposition of wood harvest and charcoal quotas. It was observed that none of the policy interventions in this study resulted in reduced degradation and deforestation, which posits a dilemma to the policy makers and implementers. However, we conclude that a well implemented system for taxes or quota restrictions would enhance sustainable resource use in the remaining woodland areas. These interventions are highly limited by implementation and enforcement problems that need to be properly addressed by policy makers and planners.

- [244] D G Nderitu, F T Sparrow, and Z Yu. Generating expansion model incorporating compact DC power flow equations. In *Proceedings of the American Power Conference*, volume 1, pages 82–87, 1998.

KEY: NderEtAl1998

ANNOTATION: This paper presents a compact method of incorporating the spatial dimension into the generation expansion problem. Compact DC power flow equations are used to provide real-power flow coordination equations. Using these equations the marginal contribution of a generator to the total system loss is formulated as a function of that generator's output. Incorporating these flow equations directly into the MIP formulation of the generator expansion problem results in a model that captures a generator's true net marginal cost, one that includes both the cost of generation and the cost of transport. This method contrasts with other methods that iterate between a generator expansion model and an optimal power flow model. The proposed model is very compact and has very good convergence performance. A case study with data from Kenya is used to provide a practical application to the model.

- [245] Molengar Ngoundo, Chun-E Kan, Yu-Chuan Chang, Shioh-Long Tsai, and I Tsou. Options for water saving in tropical humid and semi-arid regions using optimum compost application rates. *Irrigation And Drainage*, 56(1):87–98, February 2007.

KEY: NgouEtAl2007

ANNOTATION: Water saving technology interests crop producers in both the humid and semi-arid regions of the tropics. The amount of irrigation water use could be substantially reduced by the application of compost. The objective of this study was to assess irrigation application and water saving through the optimum rate of compost application. Results show that in both tropical humid and semi-arid regions, compost application on some of the "thirstiest" cash crops is a reliable way of saving water. The net irrigation depths were substantially raised from the soil treated with chemical fertilizer to the compost-amended soil, and as a consequence, lowered the number of irrigation applications in amended soil. The difference of the number of irrigation ranged from 1 to 2 and 1 to 5 applications in tropical humid and semi-arid regions, respectively. With rainfall, supplemental Irrigation was only necessary for rice and cabbage in tropical humid regions, while in semi-arid regions, irrigation constitutes the main source of crop water supply. Without rainfall, the quantity of water saved was estimated at 15.4 and 14.5% of the total water need in tropical humid and semi-arid regions respectively; with rainfall it was 54.7 and 34.9%. In Chad (a semi-arid region), this accounted for about 1.6% on average of the total Lake Chad annual inflow.

- [246] I Nhantumbo, J B Dent, and G Kowero. Goal programming: Application in the management of the miombo woodland in Mozambique. *European Journal of Operational Research*, 133:310–322, 2001.

KEY: NhanEtAl2001

ANNOTATION: Community-based management of natural resources is a priority in Mozambique's policy on forestry and wildlife resources. In essence the government's policy is to manage the natural resources in partnership with the rural communities and the private sector. This represents a change in policy in the agricultural and natural resources sectors, and has potential for significant

impact in economic development. This paper demonstrates the potential for employing goal programming as a planning tool in participatory natural resource management in Mozambique. The focus is on the miombo woodlands, which are the main natural forest resources in the country and which most of the local communities, the forestry and tourist industries depend on for a variety of forest products and services.

- [247] A Niang, E Styger, A Gahamanyi, D Hoekstra, and R Coe. Fodder-quality improvement through contour planting of legume-shrub/grass mixtures in croplands of Rwanda highlands. *Agroforestry Systems*, 39(3):263–274, 1998.

KEY: NianEtAl1998

ANNOTATION: The leguminous woody shrub species *Sesbania sesban* and *Calliandra calothyrsus* were planted with the grasses *Permisetum purpureum* and *Setaria splendida* on contour lines in association with wheat and beans in order to improve the grass based fodder system in the Buberuka highlands of Rwanda. *Setaria*, *calliandra* and *sesbania* showed a higher productivity when shrub and grass species were mixed than in the sole stand. The crude protein yield of all grass-shrub mixtures was higher than in grasses alone and the crude protein of the grasses was increased when combined with a leguminous shrub. *Calliandra* with *Setaria* gave the highest fodder quality and showed the lowest competition with crops. An optimal system for satisfying dry matter and protein requirements of local and improved cattle was estimated by linear programming. Shortest length of fodder planting is obtained by the *pennisetum* based system in sole stand and in combination with *calliandra*. The crop loss was the least when *Setaria* was grown alone or in combination with *calliandra*. From production, nutrition and economic considerations it appears that leguminous shrubs have a role in improving fodder production in the Rwandan highlands.

- [248] C F Nicholson. Review of methods for modelling systems evolution. Discussion Paper 3, ILRI (International Livestock Research Institute), Nairobi, Kenya, 2007.

KEY: Nich2007

- [249] G B Nkamleu. Productivity growth, technical progress and efficiency change in African agriculture. *African Development Review*, 16:203–222, 2004.

KEY: Nkam2004

ANNOTATION: The paper examines the economic performance of a large number of African countries using an international comparable data set and the latest technique for analysis. The paper focuses on growth in total factor productivity and its decomposition into technical change and efficiency change components. The analysis is undertaken using data envelopment analysis. The present study uses data of 16 countries over the period 1970–2001. It was found that, globally, during that period, total factor productivity has experienced a positive evolution in sampled countries. This good performance of the agricultural sector was due to good progress in technical efficiency rather than technical progress. The region suffered a regression in productivity in the 1970s, and made some progress during the 1980s and 1990s. The study also highlights the fact that technical change has been the main constraint of achievement of high levels of total factor productivity during the reference period in sub-Saharan Africa. Contrariwise, in Maghreb countries, technological change has been the main driving force of productivity growth. Finally, the results indicate that institutional factors as well as agro-ecological factors are important determinants of agricultural productivity growth.

- [250] A M Noor, P W Gikandi, S I Hay, R O Muga, and R W Snow. Creating spatially defined databases for equitable health service planning in low-income countries: The example of Kenya. *Acta Tropica*, 91(3):239–251, 2004.

KEY: NoorEtAl2004

ANNOTATION: Equity is an important criterion in evaluating health system performance. Developing a framework for equitable and effective resource allocation for health depends upon knowledge of service providers and their location in relation to the population they should serve. The last available map of health service providers in Kenya was developed in 1959. We have built a health service provider database from a variety of traditional government and opportunistic non-government sources and positioned spatially these facilities using global positioning systems, hand-drawn maps, topographical maps and other sources. Of 6674 identified service providers, 3355 (50%) were private sector, employer-provided or specialist facilities and only 39% were registered in the Kenyan Ministry of Health database during 2001. Of 3319 public service facilities supported by the Ministry of Health, missions, not-for-profit organizations and local authorities, 84% were registered on a Ministry of Health database and we were able to acquire co-ordinates for 92% of these. The ratio of public health services to population changed from 1:26,000 in 1959 to 1:9300 in 1999–2002. There were 82% of the population within 5 km of a public health facility and resident in 20% of the country. Our efforts to recreate a comprehensive, spatially defined

list of health service providers has identified a number of weaknesses in existing national health management information systems, which with an increased commitment and minimal costs can be redressed. This will enable geographic information systems to exploit more fully facility-based morbidity data, population distribution and health access models to target resources and monitor the ability of health sector reforms to achieve equity in service provision.

- [251] E A Nuppenau. Minimal cost transport of agricultural products between Malawi, Zambia, and Zimbabwe — results from a case study of intra-regional trade in maize. *Quarterly Journal of International Agriculture*, 30(1):51–66, 1991.

KEY: Nupp1991

ANNOTATION: The consequences of regional trade in maize, the staple food crop in Malawi, Zambia, and Zimbabwe, are investigated. A linear programming model is used to investigate a strategy of international shipments of maize from surplus to deficit areas. Optimal intra-national transport schemes without trade are modelled to serve as a reference system. Regional trade results in a reduction in transport costs of at least USD 7 million or 12% compared to the reference system. Furthermore, trade patterns in the case of drought are investigated to demonstrate how regional trade contributes to national food security. It appears that a reasonably likely severe drought in Zimbabwe would make imports from third countries via the port of Beira in Mozambique imperative. Since a drought of this type occurring simultaneously in all three countries creates insurmountable problems in an one-period model, a two-period model containing a normal year followed by a drought year is analyzed. This model allows stockpiling to transfer maize not utilized in surplus areas in the first year into additional supply in the drought year. This model reveals that, if there is stockpiling, Zimbabwe should keep the highest stocks of about 500 000t to cover for a drought which prevails only with a probability of 5% or once every 20 years. Lower risk aversion, of course, reduces storage activities.

- [252] Joachim Binam Nyemeck and Guy Blaise Nkamleu. Potentiel de productivité et efficacité technique du secteur agricole en Afrique. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 54(3):361–377, September 2006.

KEY: NyemNkam2006

ANNOTATION: This study utilizes frontier metaproduction functions to analyze inter-region agricultural productivity differences. Technical efficiency scores are examined through estimation of stochastic frontiers for 16 African countries divided into three different regions (West Africa, East and Southern Africa, and North Africa) from 1970 to 2001. The idea is to explore the differences in efficiency and technological gaps of agricultural sector. Apart of common traits that characterize African agricultural sector, countries exhibit national and regional specificities. These diversities are such that it is difficult to make valuable generalizations. It appears from the results that: in West Africa, the level of technology is relatively good, meaning that there is no problem of input constraints. By contrast, the efficiency with which inputs are used is very low. The situation is very different in the East and Southern Africa, with the level of technology relatively low and appreciable technical level. At least, the North Africa countries make a performing mixture between technology and efficiency.

- [253] Rose A Nyikal and Willis O Kosura. Risk preference and optimal enterprise combinations in Kahuro division of Murang'a district, Kenya. *Agricultural Economics*, 32(2):131–140, 2005.

KEY: NyikKosu2005

ANNOTATION: Financing smallholder farming has been one of the major concerns of Kenya's agricultural development efforts. Many credit programs have evolved over the years but with dismal performance. In a study that sought to find the best way to finance smallholder agriculture, it became necessary to analyze and document, in the first place, the farmers' preferred enterprise patterns. Any financial innovations would hence address the preferred patterns. Of particular interest was the effect of risk preference on such patterns, which had been ignored in many previous farm management studies. Murang'a district was chosen as a typical smallholder district. Sample farmers, obtained through cluster sampling, were visited and structured questionnaires administered to cover farm events and physical resources of short rains 1995 to long rains 1996. This formed a basis for formulating the farm patterns. A quadratic programming model was used to analyze observed farm plans. The model incorporates farmers' risk preferences, revenue fluctuations, and resource and subsistence restrictions. The results showed that: (1) changes in risk preference do affect the optimal crop combinations; (2) the typical cropping pattern is rational as the farmer meets both food and cash under modest variability of income; (3) insisting on producing most subsistence food requirements by the farmers reduces efficiency and limits the feasible plans.

- [254] W O Ochola and P Kerkides. An integrated indicator-based spatial decision support system for land quality assessment in Kenya. *Computers and Electronics in Agriculture*, 45(1-3):3-26, December 2004.
 KEY: OchoKerk2004
 ANNOTATION: Sustainable land management can be achieved through the implementation of agricultural practices that are informed by in-depth knowledge of the processes occurring in farms and the larger landscape of which they are part. A prototype interactive spatial decision support system (SDSS) has been developed to assist land use scientists, agricultural extension support personnel and farmers to classify and characterise land quality, assess sustainable land management and identify potential land use solutions at the farm recommendation unit and resource management domain levels in Kenya. The system implements a generic land quality assessment framework that integrates farmer-led participatory sustainability assessment with specialist input into a multi-disciplinary perspective. The system was conceived in support of methodological studies to identify, evaluate and interpret indicators of land quality. It provides a platform for formulating indicators to describe biophysical, socio-cultural and economic processes in agro-ecosystems. It integrates modular assessment, database management sub-systems and geographical information system (GIS). It has been structured to include a project environment, land quality data acquisition control, assessment and output engine and land quality spatial analysis. The output includes visual land quality diagrams and interactive land quality and land attribute quality maps. In its present structure, it is robust and specific enough to encapsulate the major land quality assessment indicators, yet broad enough to allow flexibility for application in different parts of Kenya.
- [255] W O Ochola, P Kerkides, and I Argyrokastritis. Water resource hazard management system: Assessing sustainable practices at the farm and catchment scales. *Irrigation and Drainage*, 51(3):243-255, September 2002.
 KEY: OchoEtAl2002
 ANNOTATION: Water quality is a pivotal environmental indicator of sustainable land management and environmental 'health'. Hazards to water resource use at the farm and catchment scales have far-reaching physical, biological, environmental and socio-economic impacts. These impacts are exacerbated by on-site and off-site agricultural and non-agricultural activities. A prototype water hazard management decision support system that uses an integrated framework to identify, by origin, hazards and related best water management practices guidelines is proposed. The system recommends best management guidelines with respect to the inherent water resource use mitigations. The system has been calibrated by and applied to expert knowledge and experimental and survey data from Kiumbu Catchment in central Kenya. Suggestions are made for the inclusion of GIS capabilities for the production of water resource assessment maps and other spatial water quality indicators.
- [256] I A Odeyemi. Location-allocation modelling of veterinary services in Africa: a case study of Zimbabwe. Technical report, Institute of Ecology and Resource Management, University of Edinburgh, Edinburgh, Scotland, U.K., 1996.
 KEY: Odey1996
- [257] I A Odeyemi. *An economic evaluation of the effect of privatisation policy on animal health service delivery in Africa*. PhD thesis, Institute of Ecology and Resource Management, University of Edinburgh, Edinburgh, Scotland, 1999.
 KEY: Odey1999
- [258] Adedapo Odulaja and Fassil G Kiros. Modelling agricultural production of small-scale farmers in sub-Saharan Africa: A case study in western Kenya. *Agricultural Economics*, 14(2):85 - 91, 1996.
 KEY: OdulKiro1996
 ANNOTATION: Small-scale farmers are known to produce the greater proportion of food consumed in the Third World, especially in sub-Saharan Africa. The various national and international agricultural research centres located in these parts of the world have developed agricultural packages which have been proven, at experimental levels, to be highly productive. However, small-scale farmers in these areas continue to produce at levels far below the capacities of these packages as predicted from experimental results. Consequently, these farmers, despite their relatively large number, could not produce enough to feed themselves let alone the general population. To improve the quality of life of these farmers in particular, and the population of the Third World in general, there is a need to study the various factors responsible for low agricultural production at the household level. Models relating production to the various factors need to be formulated to improve our understanding of the functional relationships. This in turn could lead to relevant national and international policies with respect to small-scale farmers in the Third World. In this paper, we develop models to predict production given these factors. For simplicity, the parameters of the models are limited to land size (or herd size), environmental effect and management effect. A statistical examination of our model fitted to a set of survey data on this subject revealed that

improving the farmers' management level could greatly enhance their production. Further statistical analysis of the data set showed that the various factors constituting the farmers' management level could broadly be classified into three groups: resources (labour and farm implements), personal characteristics (educational level and age) and external assistance (contact with extension agents/assistance) in that order of importance. We discuss the importance of these findings in the formulation of policies concerning small-scale farmers in sub-Saharan Africa.

- [259] P O Odwori and D O Ogweno. Modelling forest plantation development in Kenya. *Discovery and Innovation*, 14 (SUPPL. 1):37–48, 2002.

KEY: OdwoOgwe2002

ANNOTATION: Kenya has been self-sufficient in industrial round wood because of an intensive industrial plantation program initiated in 1900. However, a future national roundwood deficit has been forecasted if prevailing dismal plantation management standards continue. This paper discusses the results of a study conducted to investigate consequences of some options for plantation development on roundwood production to 2030. The results indicate that if present plantation management standards continue, roundwood production will experience an annual deficit of between 100,000 m³ and 1,000,000 m³ over the planning horizon. However, the country could meet future demand by improving plantation management standards through increased investment in plantation management. This would also increase profits from sale of industrial roundwood by up to 100%. The study recommends that further work should involve development of a full sectoral model for use in investigating options and consequences of plantation development.

- [260] S Ondimu and H Murase. Reservoir level forecasting using neural networks: Lake Naivasha. *Biosystems Engineering*, 96(1):135–138, January 2007.

KEY: OndiMura2007

ANNOTATION: Six feature groups comprising of water levels, rainfall, evaporation rate, discharges for rivers Malewa and Gilgil and one pair of time harmonics were used to develop neural network models to forecast water levels for Lake Naivasha in Kenya. Six elements were used from each feature group. Some feature groups were compressed using the Karhunen-Loeve Transform (KLT) to reduce their dimensions. The neural network models developed were able to forecast effectively the reservoir levels for the lake for four consecutive months after a given month and given data for six consecutive months prior to the month. It was found that the more the number of feature groups used, the higher the ability of neural networks to forecast accurately the reservoir levels. Data compression generally reduced the size and computation time of the models.

- [261] G O Ototo and D O Ogweno. Wood supply and forest regeneration consequences of integrated log allocation in western Kenya. *Southern African Forestry Journal*, 206:27–33, 2006.

KEY: OtotoOgwe2006

ANNOTATION: The present system of log sales from softwood plantations in Kenya is by stumpage to single product mills. This harvesting system leads to pulping of large diameter logs while allocation of small diameter logs to sawmills is a major cause of low recovery. This study examined future roundwood supply from softwood plantations in Western Kenya under the existing log sales system and under integrated allocation of sawlogs, plylogs and pulpwood to processing mills with a forest estate model. The present log sales system leads to a roundwood deficit over the planning horizon while wood supply under integrated harvesting meets demand over the same period. Under the present scenario, 56% of the harvested stands are replanted into a pulpwood-working circle as opposed to 11% under the integrated harvesting scenario. The rest of the area is regenerated into sawlog crops. Matching wood processing options and log production strategies to stands scheduled for harvest can therefore improve sustainability of roundwood supply from the existing softwood plantation area.

- [262] Trygve Ottersen, Deogratius Mbilinyi, Ottar Mstad, and Ole Frithjof Norheim. Distribution matters: Equity considerations among health planners in Tanzania. *Health Policy*, 85(2):218 – 227, 2008.

KEY: OtteEtAl2008

ANNOTATION: Maximising health as the guiding principle for resource allocation in health has been challenged by concerns about the distribution of health outcomes. There are few empirical studies that consider these potentially divergent objectives in settings of extreme resource scarcity. The aim of this study is to help fill this knowledge gap by exploring distributional preferences among health planners in Tanzania. A deliberative group method was employed. Participants were health planners at district and regional level, selected by strategic sampling. The health planners alternated between group discussion and individual tasks. Respondents ranked health programmes with different target groups, and selected and ranked the reasons they thought should be given most

importance in priority setting. A majority consistently assigned higher rankings to programmes where the initial life expectancy of the target group was lower. A high proportion of respondents considered 'affect those with least life expectancy' to be the most important reason in priority setting. Distribution of health outcomes, in terms of life-years, matters. Specifically, the lower the initial life expectancy of the target group, the more important the programme is considered. Such preferences are compatible, within the sphere of health, with what ethicists call 'prioritarianism'.

- [263] Christian M Overgaard. Solid waste planning in Tanzania — A decision support system for Dar es Salaam. MSc, Institute of Mathematical Statistics and Operations Research, The Technical University of Denmark., Lyngby, Denmark, 1991.

KEY: Over1991

- [264] J S Pachpute. A package of water management practices for sustainable growth and improved production of vegetable crop in labour and water scarce Sub-Saharan Africa. *Agricultural Water Management*, 97(9):1251–1258, 2010.

KEY: Pach2010

ANNOTATION: A package of water management practices including pitcher irrigation method and water conserving techniques of manure application and mulching is experimented for sustainable growth and improved production of cucumber crop in Makanya village in North Eastern Tanzania. The increase in total yield due to package of water management practices is 203 per cent and water use efficiency obtained is 12.06 kg m⁻³. The seasonal water requirement of cucumber crop under package of water management practices ranges from 146.30 to 198.10 mm, which is on an average 4.19 times less as compared to control treatment of can irrigation. The irrigation interval in package of water management practices is 4.9 times higher than the can irrigation method. The water and labour uses are reduced by 75.9 and 73 per cent, respectively in package of water management practices. The results showed that the self-regulative nature of pitchers and moisture retention by water conserving techniques is helpful in mitigating water stress in crop root zone. The moisture retention period in soil is increased assisting reduction of labour hours required in irrigation. In local context, the water management practices included in the package are easy to understand, adopt, operate and maintain.

- [265] P N Pali, R J Delve, E Nkonya, and B Bashaasha. Using linear programming to optimize the use of biomass transfer and improved fallow species in eastern Uganda. Technical Report 98, Centro Internacional de Agricultura Tropical (CIAT), Kampala, Uganda, CIAT, P.O. Box 6247, Kampala, Uganda, 2004.

KEY: PaliEtAl2004

ANNOTATION: Most soils in sub-Saharan Africa (SSA) have declining soil fertility, with low available nitrogen (N) and in many areas deficiencies in Phosphorus (P). Soil fertility measures soil health and is a crucial factor in crop production. Technologies exist that can replenish soil fertility but many are constrained by access to input or the availability and costs of labour therefore contributions of organic and inorganic fertilizers have been advocated by many. On-farm trials with 10 farmers to compare the effectiveness of different sources of N were conducted. This paper uses a linear programming analysis to determine the optimal combination of organic and inorganic soil improvement options. The incorporation of 100% and 50% of above-ground biomass of improved fallow (IF) species (*Mucuna pruriens* and *Canavalia eniformis*) and the use of biomass transfer (BT) species (*Tithonia diversifolia*) in combination with inorganic fertilizer were investigated. The optimal treatments for maize productivity were found to be 100% incorporation of above-ground *Mucuna* biomass on 0.06 hectares of land and 0.9 t ha⁻¹ *Tithonia* + N on 0.82 hectares of land. This solution would give an optimal net benefit of 276.8 United States Dollars over three cropping seasons. An investment of USD 288.4 would be required and a minimum of 299.3 labour days over three cropping seasons. All IF and BT options in this solution are profitable. Adoptable technologies depend on their profitability and practicability.

- [266] Richard William Palmer-Jones. Irrigation system operating policies for mature tea in Malawi. *Water Resources Research*, 13(1):1–7, 1977.

KEY: Palm1977

ANNOTATION: The author shows that the distribution of water within the root zone, at least for tea in Malawi, plays an important part in determining response to irrigation. This means that two or more soil moisture state variables will be necessary in the dynamic programming (DP) method of finding the optimal application policy, and this makes DP even more difficult to use in practice than has been previously indicated.

- [267] I M Pandey and S Ramnarayan. Agricultural Finance Corporation, Zimbabwe. *Vikalpa*, 19(2):47–61, April–June 1994.

KEY: PandRamn1994

ANNOTATION: Agricultural Financial Corporation, Zimbabwe aims at promoting and assisting agriculture industry in Zimbabwe by making available credit for a wide range of development and agricultural purposes. In pursuance of this aim, AFC makes available short, medium and long-term loans to eligible individuals, farmer's associations, cooperative agricultural unions, companies, societies, and informal groups of farmers. The following issues are raised in this case study. First, what are the major changes in the environment of AFC's strategy to meet the demands of the new environment? Second, how should AFC be organized to perform a developmental role? What skills, work methods, and culture should it develop? Third, what should be the programme for human resource development and financial policy to fulfil the organization's mission and objectives?

- [268] A Panin and R Brokken. Effects of alternative draught animal systems on farm output and income for smallscale farmers in the Ethiopian Highlands. *Quarterly Journal of International Agriculture*, 31(2):162–174, 1992.

KEY: PaniBrok1992

ANNOTATION: A linear programming model was used to analyse the economic performance of three alternative animal traction technologies in smallholding farming systems in Ethiopian Highlands. These are: traditional oxen pair, single ox, and dual purpose crossbred cows. The model tests these options against alternative policies of buying or rearing replacements for the draught animals and in respect of increasing or decreasing land area by 1 ha from the current norm of 2.55 ha. Comparison of the model results for the three traction technologies demonstrates that dual purpose crossbred cows for milk and draught are the most profitable option. The technology has the potential of increasing net farm income for smallholders at the current levels of their available resources. Sensitivity analysis with land as the only parametric variable indicates that with reduced area only the single ox can be replaced by farm-bred animals, but under normal and increased land areas replacements can be bred for all the three options. Animal traction time available from both the single ox and traditional oxen pairs proved limiting for fully cultivating 2.55 ha of cropland. Unlike these two technologies, land constrained the potential performance of the cow traction system.

- [269] Neville A Parker. Rural highway route corridor selection. *Transportation Planning and Technology*, 3(4):247–256, 1977.

KEY: Park1977

ANNOTATION: The selection of a rural highway corridor between designated termini is approached as the simultaneous selection of line and grade of a particular alignment in the corridor. The selection is facilitated by the successive application of linear programming and shortest path techniques. A model is presented in which the inputs are terrain elevations, design constraints on overall grade, terminal grades and elevations, and restricted areas of passage. The output consists of a user-specified number of alternative corridors, selected on the basis of minimum sum of the deviations of their representative profiles from the original ground. The model is applicable to situations where route selection is dominated by construction considerations. A hypothetical example and an actual application demonstrate the utility of the methodology. (This paper is concerned with Tanzania.)

- [270] Lily Parshall, Dana Pillai, Shashank Mohan, Aly Sanoh, and Vijay Modi. National electricity planning in settings with low pre-existing grid coverage: Development of a spatial model and case study of Kenya. *Energy Policy*, 37(6):2395–2410, June 2009.

KEY: ParsEtAl2009

ANNOTATION: We develop a spatial electricity planning model to guide grid expansion in Countries With low preexisting electricity coverage. The model can be used to rapidly estimate connection costs and compare different regions and communities. Inputs that are modeled include electricity demand, costs, and geographic characteristics. The spatial nature of the model permits accurate representation of the existing electricity network and population distribution, which form the basis for future expansion decisions. The methodology and model assumptions are illustrated using country-specific data from Kenya. Results show that under most geographic conditions, extension of the national grid is less costly than off-grid options. Based on realistic penetration rates for Kenya, we estimate an average connection cost of \$1900 per household, with lower-cost connection Opportunities around major cities and in denser rural regions. In areas with an adequate pre-existing medium-voltage backbone, we estimate that over 30% of households could be connected for less than \$1000 per connection through infilling. The penetration rate, an exogenous factor chosen by electricity planners, is found to have a large effect on household connection costs, often

outweighing socio-economic and spatial factors such as inter-household distance, per-household demand, and proximity to the national grid.

- [271] Barbara Paterson, Greg Stuart-Hill, Les G Underhill, Tim T Dunne, Britta Schinzel, Chris Brown, Ben Beytell, Fanuel Demas, Pauline Lindeque, Jo Tagg, and Chris Weaver. A fuzzy decision support tool for wildlife translocations into communal conservancies in Namibia. *Environmental Modelling and Software*, 23(5):521–534, May 2008.

KEY: PateEtAl2008

ANNOTATION: A fuzzy logic knowledge based decision support system, Wildlife Introduction Advisor, was developed using NetWeaver to standardise the decision making process of selecting communal conservancies for wildlife translocation in Namibia. Wildlife translocations are a valuable conservation tool with benefits for both local communities and wildlife populations, but are often undertaken in an ad hoc fashion. In Namibia, communal conservancies present a conservation opportunity for the expansion of wildlife ranges but the economic opportunities associated with wildlife create difficult situations of having to decide who gets animals and who does not. The Wildlife Introduction Advisor is the result of experts' agreement on structuring and prioritising the main factors that need to be considered. Both the validity of the system outputs and their sensitivity to input changes were evaluated through a series of tests, which show that it is possible to use a fuzzy logic decision support system to aid the selection of translocation sites for wildlife species. A knowledge based decision support tool such as Wildlife Introduction Advisor is an effective tool for a wildlife agency because it standardises the decision making process and thus enhances transparency and management accountability

- [272] Elisabeth Paul. Evaluating Fair Trade as a development project: methodological considerations. *Development in Practice*, 15(2):134–150, April 2005.

KEY: Paul2005

ANNOTATION: This article identifies the need for an appropriate methodology for evaluating Fair Trade, given that most evaluations to date have been in-house or commissioned reviews and hence have not followed a consistent approach. Focusing on the development aspects of Fair Trade, the article reviews a range of impact evaluation methods and presents a detailed methodology for analysing Fair Trade. This methodology incorporates standard project evaluation criteria and is based on a wide range of proven methods for collecting and analysing data, principally qualitative but also quantitative. This framework is a modular package from which practitioners may select according to their needs and means, while still retaining an overarching logic. The article illustrates its use by reference to evaluations undertaken in Costa Rica, Ghana, Nicaragua, and Tanzania. The approach allows for a comprehensive understanding of Fair Trade programmes and enables these to be compared with conventional development projects.

- [273] P O Pedersen. The structure of small service centers under conditions of uncertain supplies. *International Regional Science Review*, 14(3):307–316, 1992.

KEY: Pede1992

ANNOTATION: Belsky and Karaska claim that Rondinelli's functional integration approach to locational planning in rural areas gives more weight to the integration and articulation of an urban hierarchy than to increased access of rural populations to urban-based services. They advocate a demand-based location-allocation approach. Neither approach is concerned with the organization of the supply system. A study of rural centers in Zimbabwe shows that the structure of rural service centers in developing countries depends as much on supply factors as on demand factors.

- [274] John Pender, Ephraim Nkonya, Pamela Jagger, Dick Sserunkuuma, and Henry Ssali. Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda. *Agricultural Economics*, 31(2-3):181–195, 2004.

KEY: PendEtAl2004

ANNOTATION: This paper estimates a structural econometric model of household decisions regarding income strategies, participation in programs and organisations, crop choices, land management, and labour use, and their implications for agricultural production and soil erosion; based upon a survey of over 450 households and their farm plots in Uganda. Many factors have context-specific impacts and involve trade-offs between increasing production and reducing land degradation. Government agricultural extension and training programs contribute to higher value of crop production in the lowlands, but to soil erosion in the highlands. By contrast, non-governmental organization (NGO) programs focusing on agriculture and environment help to reduce erosion, but have less favourable impacts on production in the lowlands. Education increases household incomes, but also reduces crop production in the lowlands. Poverty has mixed impacts on agricultural production, depending on the nature of poverty: smaller farms obtain higher crop production per hectare, while households with fewer livestock have lower crop production. Population pressure

contributes to agricultural intensification, but also to erosion in the densely populated highlands. Several household income strategies contribute to increased value of crop production, without significant impacts on soil erosion. We find little evidence of impact of access to markets, roads and credit, land tenure or title on agricultural intensification and crop production and land degradation. In general, the results imply that the strategies to increase agricultural production and reduce land degradation must be location-specific, and that there are few “win-win” opportunities to simultaneously increase production and reduce land degradation.

- [275] Nicolas Picard, Yves Yalibanda, Salomon Namkossereana, and Fidele Baya. Estimating the stock recovery rate using matrix models. *Forest Ecology and Management*, 255(10):3597–3605, May 2008.

KEY: PicaEtAl2008

ANNOTATION: The stock recovery rate, that is the ratio of the exploitable wood stock at the end of a felling cycle over the exploitable wood stock at the beginning of this cycle, is a key parameter used in the management plans of the natural forests in central Africa. Estimating this rate requires a model of forest dynamics. Forest managers usually use a formula that is based on a simple model that assumes constant vital rates. A generalization of this formula is based on matrix models of population dynamics. The stock recovery rate at the end of the k th felling cycle can be simply computed using matrix models. The asymptotic stock recovery rate (that is the limit as k tends to infinity) is the asymptotic growth rate (that is the dominant eigenvalue) of a transition matrix that includes harvest. The estimate of the stock recovery rate can be completed by its confidence interval using bootstrap methods. When applied to sapelli (*Entandrophragma cylindricum*, Meliaceae), a major timber species in central Africa, it turns out that a few thousands observations are required to estimate the stock recovery rate with an accuracy of at least 10%. The number of observations available on an experimental site in the Central African Republic does not permit to do better than an accuracy of about 45% at level 95%. This does not permit to conclude whether the asymptotic stock recovery rate is greater or less than one. As a conclusion, in management plans in central Africa, stock recovery rates should be given together with an indication of the variability of their estimate (standard error or confidence limits).

- [276] B Vander Plaetse, G Hlatiwayo, L Van Eygen, B Meessen, and B Criel. Costs and revenue of health care in a rural Zimbabwean district. *Health Policy and Planning*, 20(4):243–251, 2005.

KEY: PlaeEtAl2005

ANNOTATION: The District Health Executive of Tsholotsho district in south-west Zimbabwe conducted a health care cost study for financial year 1997/98. The study’s main purpose was to generate data on the cost of health care of a relatively high standard, in a context of decentralization of health services and increasing importance of local cost-recovery arrangements. The methodology was based on a combination of step-down cost accounting and detailed observation of resource use at the point of service. The study is original in that it presents cost data for almost all of the health care services provided at district level. The total annualized cost of the district public health services in Tsholotsho amounted to USD 10 per capita, which is similar to the World Bank’s Better Health in Africa study (1994) but higher than in comparable studies in other countries of the region. This can be explained by the higher standards of care and of living in Zimbabwe at the time of the study. About 60% of the costs were for the district hospital, while the different first-line health care facilities (health centres and rural hospitals together) absorbed 40%. Some 54% of total costs for the district were for salaries, 20% for drugs, 11% for equipment and buildings (including depreciation) and 15% for other costs. The study also looked into the revenue available at district level: the main source of revenue (85%) was from the Ministry of Health. The potential for cost recovery was hardly exploited and revenue from user fees was negligible. The study results further question the efficiency and relevance of maintaining rural hospitals at the current level of capacity, confirm the soundness of a two-tiered district health system based on a rational referral system, and make a clear case for the management of the different elements of the budget at the decentralized district level. The study shows that it is possible to deliver district health care of a reasonable quality at a cost that is by no means exorbitant, albeit unfortunately not yet within reach of many sub-Saharan African countries today. An important part of the population living in the Nyamandlovu area (in total some 20 000/25 000 people), where one of the three rural hospitals was located, used the different Bulawayo-based provincial hospitals for referral care more often than the Tsholotsho district hospital. The public transport lines were such that travelling to Bulawayo was a more convenient option. This implies that the figure of 163 000 for the district population is an overestimate of the population that really used Tsholotsho hospital for referral care and that the annual per capita costs are underestimated.

- [277] Catharina P B van der Ploeg, Carina van Vliet, Sake J De Vlas, Jeckoniah O Ndinya-Achola, Lieve Fransen, Gerrit J van Oortmarssen, and J Dik F. Habbema. STDSIM: A microsimulation model for decision support in sexually transmitted diseases control. *Interfaces*, 28(3):84–100, May–June 1998.
 KEY: PloeEtAl1998
 ANNOTATION: STDSIM is a dynamic stochastic simulation method for decision support in attempts to control sexually transmitted diseases (STDs). It describes the mechanisms responsible for the transmission of five STDs, including HIV/AIDS, at the level of individuals. A large variety of outcome measures (for example, STD prevalence, incidence, and mortality) can be calculated for different groups of the population (for example, adolescents, prostitutes, pregnant women, and migrants) to evaluate the effects of alternative STD control interventions. We designed the model to support decision making for different settings in developing countries, with Nairobi (Kenya) as its first application area. The model adequately describes STD prevalences and the time-trend of HIV prevalence measured in Nairobi. As an illustration of the possibilities of the model, we show model predictions of the effects of improved STD care and increased condom use on the prevalence and incidence of HIV.
- [278] A M Polderman. Cost-effectiveness of different ways of controlling intestinal schistosomiasis: A case study. *Social Science & Medicine*, 19(10):1073 – 1080, 1984.
 KEY: Pold1984
 ANNOTATION: Intestinal schistosomiasis is highly prevalent among the labourers and their families in many of the miners' villages in Maniema, Zaire. Following treatment, a quick re-infection can be observed if no measures are taken to reduce transmission. It is shown that the rate of re-infection is reduced when the water bodies around an endemic village are properly molluscicided. When, in addition to chemotherapy, a strategy of focal mollusciciding was adopted beneficial effects were visible 12 months after treatment but no longer at 20 months. In view of the comparatively small size of the human populations in the endemic villages, and due to the extent and the variety of the snail-infested water bodies, chemotherapy only, without additional measures, would seem to be the most cost-effective type of control, under the prevailing conditions. This conclusion should be revised when long term health-planning could be effectively envisaged for the area.
- [279] Tomasz Potkanski and William M Adams. Water scarcity, property regimes and irrigation management in Sonjo, Tanzania. *Journal of Development Studies*, 34(4):86–116, April 1998.
 KEY: PotkAdam1998
 ANNOTATION: This article explores the dynamics of property rights in irrigation water in Sonjo, Tanzania. It analyses an unsuccessful attempt by the ruling political group to change the institutional arrangements of water control, to serve better their private goals. This example shows that not all internal institutional innovations in the field of utilising natural resources lead to increased efficiency of the system from the point of view of the whole community. We draw on New Institutional Economics and Common Property Resource Management theory to analyse the way in which it was possible that those few within Sonjo society who are formally/nominally *the owners* of water sought to privatise de facto collective use rights of all community members. We consider why this was done in some, but not all, Sonjo communities, and we describe why this process has eventually failed.
- [280] T Pukkala and V Pohjonen. Use of linear programming in land use planning in the Ethiopian highlands. *Silva Fennica*, 24(2):235–247, 1990.
 KEY: PukkPohj1990
 ANNOTATION: Linear programming was used to analyze the land use alternatives in the Debre Birhan Fuelwood Plantation area, in the central highlands of Ethiopia. The region represents a rural, high-altitude area, where the main land uses are grazing and cultivation of barley, wheat and pulses. To alleviate fuelwood shortage, large plantations of *Eucalyptus globulus Labill.* have been established. Livestock has traditionally used the major part of the production capacity of the sites. A decrease in the number of cows, sheep, goats, horses and donkeys would facilitate a considerable increase in the production of cereals, pulses, fuelwood and construction timber. The optimal share of the land for arable crops, grazing and tree plantations would be about 40, 45 and 15% respectively.
- [281] Afaf H Rahim, Ekko C van Ierland, and Hans-Peter Weikard. Competition in the gum arabic market: a game theoretic modelling approach. *Quarterly Journal of International Agriculture*, 49(1):1–24, 2010. Philipps-Universitt Marburg, Germany Wageningen University, The Netherlands.
 KEY: RahiEtAl2010
 ANNOTATION: Gum arabic is mainly produced from two Acacias that are found in the gum belt of

Sub-Saharan Africa. These are Acacia senegal that produces high quality gum and Acacia seyal that produces low quality gum. In recent years the gum market structure has changed and Sudan lost its near monopoly position as Chad and Nigeria became important gum suppliers. In order to understand the competition between Sudan, Chad and Nigeria in the export of high and low quality gum arabic we develop a von Stackelberg model with interdependent markets. Whereas Sudan (the leader) has an absolute cost advantage in the export of high quality gum, Chad and Nigeria (the followers) have a cost advantage in the export of low quality gum. We determine the market equilibrium outcomes and study the impact of development assistance scenarios to promote either the high or low quality gum. Our results suggest that the leader is better off promoting the quality for which it has cost advantage, i.e. the high quality gum. This also leads to a lower reduction in the competitors profit than promoting low quality gum. Similarly, when followers promote the quality for which they have cost advantage, i.e. the low quality gum, this results in a lower reduction in the leader's profit than when they promote high quality gum. The best strategy of the followers is, however, sensitive with respect to the elasticities of demand.

- [282] Kossa R M Rajabu. Use and impacts of the river basin game in implementing integrated water resources management in Mkoji sub-catchment in Tanzania. *Agricultural Water Management*, 94(1–3):63–72, December 2007.

KEY: Raja2007

ANNOTATION: The Rufiji river basin in Tanzania is faced with many conflicts over water use due to water scarcity problems at local levels. In order to get water users to understand and frame their own practices, problems and solutions, and to contextualise that within the wider basin, a practical dialogue and decision support tool, called river basin game (RBG) was designed. This paper describes how RBG was used as a participatory dialogue tool to engage stakeholders in Mkoji sub-catchment (MSC), Rufiji river basin in analysing key water resources issues, and the resulting impacts. RBG was played in MSC during three different workshops, each lasting 2 days. Whereas day 1 of the game was devoted in demonstrating and discussing various scenarios on water availability and water use that had occurred in MSC, day 2 involved various group discussions, plenary sessions and agreements on ways and strategies to improve water management and increase productivity of water. Results showed that at the end of the RBG workshops, participants' understanding of system dynamics, common-property pitfalls, which issues are most critical and what solutions might be considered, was greatly enhanced. Participants learned and realised that being at the top of the river has advantages, whilst tail-end systems experience water shortages; community actions are better than individual strategies in ensuring equitable water allocation; local level water users' actions have basin-wide impacts such as environmental degradation and water scarcity to downstream areas; many solutions and strategies exist whereby crops can be grown using less water; and a sub-catchment committee is required to oversee water allocation and management. Tracer and impact studies have shown that the RBG triggered not only discussions on technical, institutional and socio-economic arrangements for equitable water allocation, but also behavioural change in the way people regard and use water. This paper concludes that the RBG is a powerful tool for creating awareness and triggering behaviour change on various water issues and the need to address water problems in a rational manner.

- [283] R Ramanathan. Combining indicators of energy consumption and CO2 emissions: a cross-country comparison. *International Journal of Global Energy Issues*, 17(3):214–227, 2002.

KEY: Rama2002

ANNOTATION: When countries are compared in terms of their carbon emission intensities, carbon emissions are normally considered as a function of either energy consumption, GDP, population or any other suitable variable. These can be termed as partial indicators as they consider emissions as a function of only one variable. Simultaneous consideration of more variables affecting carbon emissions is relatively complex. In this paper, several variables are simultaneously considered in comparing carbon emissions of countries using a new mathematical programming methodology, called the Data Envelopment Analysis. We have illustrated the use of the methodology with four variables representing CO2 emissions, energy consumption and economic activity. The illustrative analysis shows that Luxembourg, Norway, Sudan, Switzerland and Tanzania have been considered the most efficient countries, followed by India and Nigeria. Central European countries such as Poland, Romania, the Czech Republic, and South Africa are the least efficient.

- [284] A I Ratemo. *Maize market liberalisation and food security in Kenya: policy analysis and evaluation using a quadratic programming and simulation approach*. PhD thesis, University of Newcastle upon Tyne, 1997.

KEY: Rate1997

ANNOTATION: Maize is an important staple food crop in most Kenyan households. The Government

of Kenya (GOK) identifies three key policy objectives with regard to food and particularly maize production and distribution: maintain a position of broad self-sufficiency in the main foodstuffs in order to enable the nation to be fed without using scarce foreign exchange on food imports; achieve a calculated degree of security food supply for each area of the country; ensure that these foodstuffs are distributed in such a manner that every member of the population has a nutritionally adequate diet. The thesis uses a quadratic programming and simulation approach to evaluate the effects of maize market liberalisation with particular reference to food security in Kenya, treating rich and poor consumers and large and small producers separately. Four hypotheses are used to evaluate the performance of maize markets in a liberalised market: deregulated maize markets result in increased social welfare; post-liberalisation, spatial marketing margins will tend to fall to a level more closely related to marketing costs (primarily transport costs) to the benefit of consumers; post-liberalisation, traded quantities will increase, more maize will be made available to the deficit areas (poor households) at lower prices, while maize producers will increase production and thus enhance food availability; the temporal price difference will tend to rise more closely to reflect storage costs. The analytical policy tool developed here has addressed these issues and identifies key factors likely to determine food security performance in practice. The results obtained reveal outcomes that are useful for policy advice and future policy evaluation and development. The general conclusion drawn from this work is that food security objectives can be achieved in a deregulated maize market. Some groups in society will lose and others will gain. The gainers would be able to compensate the losers and thus cause an increase of net welfare benefits to the society. The major areas policy analysts may wish to focus on, concern the vulnerable groups in society where this study found the efficiency gains from deregulation are relatively modest.

- [285] Bob Rijkers, Mns Sderbom, and Josef L. Loening. A rural-urban comparison of manufacturing enterprise performance in Ethiopia. *World Development*, 38(9):1278–1296, 2010.

KEY: RijkEtAl2010

ANNOTATION: Summary Manufacturing enterprises in rural and urban Ethiopia are compared to examine how location and investment climate characteristics affect performance. Urban firms are larger, more capital intensive and have higher labor productivity than rural firms, yet there is no strong evidence of increasing returns to scale. The hypothesis that firms in rural towns have the same average total factor productivity as urban firms is not rejected; however, firms in remote rural areas are less productive. Rural firms grow less quickly than urban firms. These results can partly be attributed to differences in the quality of infrastructure, access to credit and transportation costs across rural and urban areas. Since rural firms operate in a business environment that is very different from its urban counterpart, lessons derived from urban investment climate surveys cannot immediately be transferred to rural areas.

- [286] G Rodriguez Jr. and F W Anderson. A case study of risk-return tradeoffs in a mixed farming system in highland Ethiopia. *Agricultural Systems*, 27(3):161–177, 1988.

KEY: RodrAnde1988

ANNOTATION: The role of livestock enterprises as a risk management option for subsistence smallholder farmers is examined. Specifically the issue of whether livestock enterprises can be an income stabilizing agent in a traditional mixed crop, and the livestock farming system is addressed. The analysis is based on the application of a stochastic farm-firm linear programming model; farm income is the stochastic variable. Technological and resource constraint sets which approximate those of representative smallholders in the Debre Berhan area are incorporated into the empirical framework. The data inputs to the model were collected in field surveys conducted by ILCA (International Livestock Centre for Africa) for the period 1979-83. Linear programming solutions are obtained for three situations; and results are then discussed: (1) A set of solutions where traditional farm technologies apply. (2) A set of solutions where farmers can use one ox, rather than the traditional pair, for cultivation. (3) A set of solutions where farmers can keep a relatively high-yielding crossbred cow for milk production to raise cash incomes.

- [287] J Quintino Rogado. An optimization method for the mining and beneficiation of ore blocks. *International Journal of Mineral Processing*, 2(1):59 – 76, 1975.

KEY: Roga1975

ANNOTATION: The exploitation of the iron ores of Companhia Mineira do Lobito (in Angola, producing 6 million tonnes per year) is based upon a sophisticated planning schedule which, for five years, has been successful in keeping several pertinent parameters steady, such as the number of operating wagon-scrappers and pushers, the iron content and the weight recovery of the concentrates yielded by the 4.8 TPY and 1.2 TPY HMS existing plants, as well as the proportion of fines

(0.2mm) in such concentrates, once the plants are maintained in predefined functioning points. Recently, an improvement was introduced in the planning schedule consisting of the optimization of the obtained-weight recovery. The method used consists of:

- (1) Partition of the ore deposits in sub-deposits or blocks each having a specific behaviour when treated by HMS.
- (2) A computerized optimization algorithm, to define such functioning points for the plants which maximize the overall weight recovery, simultaneously keeping the iron content of the concentrates at a predetermined value.
- (3) Establishment of working criteria for the mine which define the combination of blocks to be simultaneously or sequentially treated in order to ensure the conditions stated at (2).

This new optimization method is now being launched.

- [288] Agnes S Rwashana, Ddembe W Williams, and Stella Neema. System dynamics approach to immunization healthcare issues in developing countries: a case study of Uganda. *Health Informatics Journal*, 15(2):95–107, June 2009.

KEY: RwasEtAl2009

ANNOTATION: This article critically examines the challenges associated with demand for immunization, including the interplay of political, social, economic and technological forces that influence the level of immunization coverage. The article suggests a framework to capture the complex and dynamic nature of the immunization process and tests its effectiveness using a case study of Ugandan healthcare provision. Field study research methods and qualitative system dynamics, a feedback and control theory based modelling approach, are used to capture the complexity and dynamic nature of the immunization process, to enhance a deeper understanding of the immunization organizational environment. A model showing the dynamic influences associated with demand and provision of immunization services, with the aim of facilitating the decision making process as well as healthcare policy interventions, is presented.

- [289] Padmaja Sajjala. A linear programming analysis for small farms in Dodoma district in Tanzania. Master's thesis, North Carolina A & T State University, 1987.

KEY: Sajj1987

ANNOTATION:

- [290] Joshua A Salomon and Christopher J L Murray. Modelling HIV/AIDS epidemics in sub-Saharan Africa using seroprevalence data from antenatal clinics. *Bulletin of the World Health Organisation*, 79(7):596–607, July 2001.

KEY: SaloMurr2001

ANNOTATION: OBJECTIVE: To improve the methodological basis for modelling the HIV/AIDS epidemics in adults in sub-Saharan Africa, with examples from Botswana, Central African Republic, Ethiopia, and Zimbabwe. Understanding the magnitude and trajectory of the HIV/AIDS epidemic is essential for planning and evaluating control strategies. METHODS: Previous mathematical models were developed to estimate epidemic trends based on sentinel surveillance data from pregnant women. In this project, we have extended these models in order to take full advantage of the available data. We developed a maximum likelihood approach for the estimation of model parameters and used numerical simulation methods to compute uncertainty intervals around the estimates. FINDINGS: In the four countries analysed, there were an estimated half a million new adult HIV infections in 1999 (range: 260 to 960 thousand), 4.7 million prevalent infections (range: 3.0 to 6.6 million), and 370 thousand adult deaths from AIDS (range: 266 to 492 thousand). CONCLUSION: While this project addresses some of the limitations of previous modelling efforts, an important research agenda remains, including the need to clarify the relationship between sentinel data from pregnant women and the epidemiology of HIV and AIDS in the general population.

- [291] Johannes Sauer and Jumanne M Abdallah. Forest diversity, tobacco production and resource management in Tanzania. *Forest Policy and Economics*, 9(5):421–439, January 2007.

KEY: SaueAbda2007

ANNOTATION: This paper aims to deliver empirical evidence on the links between production efficiency, biodiversity, and resource management by analysing a case study on small-scale tobacco production in the Miombo woodlands in Tanzania. The subsistence nature of tobacco production in Tanzania suggests that most power-driven equipments, fertilizers and sustainable crop processing technologies are beyond the reach of most small-scale tobacco growers. The consequence is that in order to expand their production, tobacco farmers heavily substitute such inputs by an increasing use of wood. Hence, an increasing amount of forest land is cleared by the farmers resulting in forest degradation and a loss of biodiversity. This study determines in a first step the efficiency of tobacco production bordering the Miombo woodlands in Tanzania as well as investigates factors for the

relative inefficiency on farm level. In a second step, the relation between forest species diversity in the surrounding woodlands and tobacco production efficiency as well as between diversity and the type of institutional arrangement with respect to forest management are empirically analysed. The results indicate that the different efficiency measures vary widely over the sample, showing a significant positive effect of the curing technology-i.e., the design of the barn-and the source of the firewood. The majority of farmers produce with increasing returns to scale. A strong positive correlation between the tobacco production efficiency and forest diversity as well as between community-based arrangements and forest diversity is revealed. This suggests that an increase in agricultural production efficiency with respect to tobacco is conducive for environmental sustainability in Tanzania. It finally supports property rights-based institutional arrangements for the management of forest resources as such motivate the sustainable management of unreserved forest resources.

- [292] Johannes Sauer and Hardwick Tchale. The economics of soil fertility management in Malawi. *Review of Agricultural Economics*, 31(3):535–560, July 2009.

KEY: SaueTcha2009

ANNOTATION: We estimated a normalized translog yield-response model using African farm-household survey data to compare the yield of smallholder maize production under integrated soil fertility management (ISFM) and chemical-based soil fertility management. Controlling for other factors, maize yield responses were higher under ISFM. Results suggest ISFM practices would significantly improve the profitability of smallholder maize production, especially under escalating fertilizer prices.

- [293] Roland E Schulze. Some Foci of Integrated Water Resources Management in the "South" which are oft-forgotten by the "North": A perspective from southern Africa. *Water Resources Management*, 21(1):269–294, January 2007.

KEY: Schu2007

- [294] Caspar Schweigman. Food security problems in sub-Saharan Africa: Operations Research as a tool of analysis. *International Transactions in Operational Research*, 15(2):173–193, March 2008.

KEY: Schw2008

ANNOTATION: For many years, the author has been involved in teaching and research in the use of Operations Research as a tool of analysis to study food security problems in sub-Saharan Africa, in particular, grass root problems of poor farmers. The paper presents an introduction to the way Operations Research methods have been applied in case studies and research projects, and discusses in retrospect the author's views on the strengths and limitations of the application of Operations Research. The paper has in particular been written for people who are not familiar with applications of Operations Research in agriculture, and are interested to learn about its potential usefulness in practice. The retrospective part is largely based on food security studies in e.g. Tanzania, Burkina Faso, Benin, Togo and Eritrea and on participation in several interdisciplinary research programmes in Africa.

- [295] Caspar Schweigman, E J Bakker, and T A B Snijders. Operations Research as a tool for analysis of food security problems. *European Journal of Operational Research*, 49(2):211–221, November 1990.

KEY: SchwEtAl1990

ANNOTATION: In the first part of the paper the role of operations research in analyzing daily life problems of farmers in developing countries is discussed. Experiences on village studies in Tanzania are reported which formed part of the training in operations research of students of the University of Dar es Salaam. In the second part, two examples of food security problems are worked out: risk of food shortage in subsistence farming in Tanzania and the use of rainfall-yield models to predict shortages of sorghum production at an early stage of the growing season in Burkina Faso. At the end of the paper, some discussion points are formulated.

- [296] Steven W Seagle and S J McNaughton. Spatial variation in forage nutrient concentrations and the distribution of Serengeti grazing ungulates. *Landscape Ecology*, 7(4):229–241, December 1992.

KEY: SeagMcNa1992

ANNOTATION: Resident grazing ungulates in the Serengeti National Park, Tanzania, are conspicuously patchy in their distribution among regions of the Park. Linear programming models that maximize nitrogen (N) consumption by foraging ungulates in Serengeti regions having high and low resident animal densities were compared using forage ingestion rate and twelve nutritional requirements as simultaneously imposed constraints on forage choice. Model results indicate that (1) growing season N or crude protein is not limiting in either region although greater Nitrogen ingestion is possible within the eastern corridor under other nutritional constraints, (2) grazing ungulates in the eastern corridor region occur in greater density and are capable of balancing

dietary requirements solely from forage while simultaneously consuming more protein than ungulates in the northeast region, and (3) rarer landscape elements are most capable of providing ungulate dietary requirements in both the northeast and eastern corridor. These results provide a nutritional basis to understand patchy spatial distributions of grazers within Serengeti regions and landscapes, and provide a partial test of the hypothesis that large generalist herbivores should graze rare forages more frequently. The ability of uncommon landscape elements to support ungulate grazing over the growing season is supported by previous ecosystem studies that demonstrate the capability of grass forages for compensatory growth and the ability of grazing to stimulate rapid nutrient recycling.

- [297] Shahriar Shams and Chikira Ibrahimu. Household waste recovery and recycling: a case study of Kigoma-Ujiji, Tanzania. *International Journal of Environment and Sustainable Development*, 2(4):412–424, 2003.

KEY: ShamIbra2003

ANNOTATION: Management of waste in most developing countries has become important for most of the cities as they try to curb and control city growth and urbanisation. The general norm where waste management had been the sole duty of municipalities has proved not to work due to lack of funds, public participation, political will and awareness. This paper looks at the general problems faced in household waste recovery and recycling, with a case study from Tanzania. A process scheme that consists of public participation, costs, social acceptance, economic benefits, and hygiene is considered. The overall conclusion is that there is a need for government commitment and general involvement of the public. The setting up of recycling industries will also ease the situation and at the same time create employment for the people.

- [298] Huda Abdelwahab Sharawi. Optimal land-use allocation in central Sudan. *Forest Policy and Economics*, 8(1):10 – 21, 2006.

KEY: Shar2006

ANNOTATION: The optimal land-use in the gerf land of central Sudan was determined from the social welfare point of view. The alternative land-use options considered were *Acacia nilotica* plantations, eucalyptus plantations and bananas. The evaluation technique adopted was cost-benefit analysis using the Little-Mirrlees-Squire-van der Tak (LMST) approach. The results indicate that eucalyptus plantations are the optimum land-use option on the basis of economic growth maximization (economic analysis) as well as maximization of economic growth with equity as a constraint (social analysis). The *A. nilotica* option came second to eucalyptus, while banana performed poorly with negative contribution in most cases. The financial analysis which used distorted market prices revealed that all three land-use alternatives were profitable, with eucalyptus being the most profitable and *A. nilotica* the least. Compared to the financial profitability, the economic profitability of the two forest options was considerably higher. In contrast, the profitability of the banana option was lowest among the three options. It is concluded that distorting agricultural policy had the impact of misallocating land to the optimal use.

- [299] N A Sherbiny and M Y Zaki. Interregional comparative advantage models in developing agriculture. *Journal Of Development Studies*, 12(1):3–17, 1975.

KEY: SherZaki1975

- [300] Mika Siljander. Predictive fire occurrence modelling to improve burned area estimation at a regional scale: A case study in East Caprivi, Namibia. *International Journal of Applied Earth Observation and Geoinformation*, 11(6):380 – 393, 2009.

KEY: Silj2009

ANNOTATION: Fires threaten human lives, property and natural resources in Southern African savannas. Due to warming climate, fire occurrence may increase and fires become more intense. It is crucial, therefore, to understand the complexity of spatiotemporal and probabilistic characteristics of fires. This study scrutinizes spatiotemporal characteristics of fires and the role played by abiotic, biotic and anthropogenic factors for fire probability modelling in a semiarid Southern African savanna environment. The MODIS fire products: fire hot spots (MOD14A2 and MYD14A2) and burned area product MODIS (MCD45A1), and GIS derived data were used in analysis. Fire hot spots occurrence was first analysed, and spatial autocorrelation for fires investigated, using Moran's I correlograms. Fire probability models were created using generalized linear models (GLMs). Separate models were produced for abiotic, biotic, anthropogenic and combined factors and an autocovariate variable was tested for model improvement. The hierarchical partitioning method was used to determine independent effects of explanatory variables. The discriminating ability of models was evaluated using area under the curve (AUC) from the receiver operating characteristic (ROC) plot. The results showed that 19.2-24.4% of East Caprivi burned when detected using

MODIS hot spots fire data and these fires were strongly spatially autocorrelated. Therefore, the autocovariate variable significantly improved fire probability models when added to them. For autologistic models, i.e. models accounting for spatial autocorrelation, discrimination was good to excellent (AUC 0.858-0.942). For models not counting spatial autocorrelation, prediction success was poor to moderate (AUC 0.542-0.745). The results of this study clearly showed that spatial autocorrelation has to be taken in to account in the fire probability model building process when using remotely sensed and GIS derived data. This study also showed that fire probability models accounting for spatial autocorrelation proved to be superior in regional scale burned area estimation when compared with MODIS burned area product (MCD45A1).

- [301] R O Simwa and G P Pokhariyal. A dynamical model for stage-specific HIV incidences with application to sub-Saharan Africa. *Applied Mathematics and Computation*, 146(1):93–104, December 2003.

KEY: SimwPokh2003

ANNOTATION: In this paper a deterministic model for HIV epidemic with three stages of disease progression among infected patients is discussed. It is assumed that the patient once infected experiences disease progression up to full-blown AIDS. Using two systems of ordinary differential equations that are coupled through a delay in one of the systems, a compartmental model for the dynamics of the HIV/AIDS epidemic is constructed. The transmission of the disease is considered to be only through heterosexual contact and vertically from an infected mother to her unborn child. Numerical integration of the equations is used for simulating the stage-specific epidemic curves, given the demographic and epidemiological parameters of the model. The simulation results with respect to Uganda's HIV/AIDS epidemic scenario obtained are found to be consistent with the published findings namely that the corresponding prevalence is a non-decreasing function of time for at least 30 years of the epidemic. Furthermore, through simulation it is noted that all the three stage-specific prevalence rate curves also satisfy this condition.

- [302] David K Smith. A bibliography of operational research applications in West Africa. *International Transactions in Operational Research*, 15(2):121–150, April 2008.

KEY: Smit2008

- [303] Robert J Smith and Senelani D Hove-Musekwa. Determining effective spraying periods to control malaria via indoor residual spraying in sub-Saharan Africa. *Journal of Applied Mathematics and Decision Sciences*, 2008(745463):1–19, 2008.

KEY: SmitHove2008

ANNOTATION: Indoor residual sprayingspraying insecticide inside houses to kill mosquitoesis an important method for controlling malaria vectors in sub-Saharan Africa. We propose a mathematical model for both regular and non-fixed spraying, using impulsive differential equations. First, we determine the stability properties of the nonimpulsive system. Next, we derive minimal effective spraying intervals and the degree of spraying effectiveness required to control mosquitoes when spraying occurs at regular intervals. If spraying is not fixed, then we determine the next best spraying times. We also consider the effects of climate change on the prevalence of mosquitoes. We show that both regular and nonfixed spraying will result in a significant reduction in the overall number of mosquitoes, as well as the number of malaria cases in humans. We thus recommend that the use of indoor spraying be re-examined for widespread application in malaria-endemic areas.

- [304] Zana C Somda, Martin I Meltzer, Helen N Perry, Nancy E Messonnier, Usman Abdulmumini, Goitom Mebrahtu, Massambou Sacko, Kandioura Toure, Salimnta Ouedraogo Ki, Tuoyo Okorosobo, Wondimagegnehu Alemu, and Idrissa Sow. Cost analysis of an integrated disease surveillance and response system: case of Burkina Faso, Eritrea, and Mali. *Cost Effectiveness and Resource Allocation*, 7(1):11 pages, accessed 26:October:2010, January 2009.

KEY: SomdEtAl2009

ANNOTATION: Communicable diseases are the leading causes of illness, deaths, and disability in sub-Saharan Africa. To address these threats, countries within the World Health Organization (WHO) African region adopted a regional strategy called Integrated Disease Surveillance and Response (IDSR). This strategy calls for streamlining resources, tools, and approaches to better detect and respond to the region's priority communicable disease. The purpose of this study was to analyze the incremental costs of establishing and subsequently operating activities for detection and response to the priority diseases under the IDSR. We collected cost data for IDSR activities at central, regional, district, and primary health care center levels from Burkina Faso, Eritrea, and Mali, countries where IDSR is being fully implemented. These cost data included personnel, transportation items, office consumable goods, media campaigns, laboratory and response materials and supplies, and annual depreciation of buildings, equipment, and vehicles. Over the period studied (2002-2005), the average cost to implement the IDSR program in Eritrea was USD0.16 per capita, USD0.04 in

Burkina Faso and USD0.02 in Mali. In each country, the mean annual cost of IDSR was dependent on the health structure level, ranging from USD35,899 to USD69,920 at the region level, USD10,790 to USD13,941 at the district level, and USD1,181 to USD1,240 at the primary health care center level. The proportions spent on each IDSR activity varied due to demand for special items (e.g., equipment, supplies, drugs and vaccines), service availability, distance, and the epidemiological profile of the country. This study demonstrates that the IDSR strategy can be considered a low cost public health system although the benefits have yet to be quantified. These data can also be used in future studies of the cost-effectiveness of IDSR.

- [305] J W Ssenyonga. The Marakwet irrigation system as a model of a systems approach to water management. In *Kerio Valley: past, present and future*, pages 96–111. University of Nairobi: Institute of African Studies (Nairobi, Kenya), 1983.

KEY: Ssen1983

- [306] David C Stifela and Jean-Claude Randrianariso. Agricultural policy in Madagascar: A seasonal multi-market model. *Journal of Policy Modeling*, 28(9):1023–1027, December 2006.

KEY: StifRand2006

ANNOTATION: The purpose of this note is to illustrate how a generic multi-market model can be adapted to the circumstances of a particular developing country to assess the impact of alternative agricultural policies on the well being of households. We describe the main features and results of a multi-market model for Madagascar that focuses on income generating activities in an agricultural sector that is characterized by seasonal variability. We find evidence that investments in rural infrastructure and commercial food storage have both direct and indirect benefits on poor households.

- [307] P V Sukhatme. The world's hunger and future needs in food supplies. *Journal Of The Royal Statistical Society Series A-General*, 124(4):463–508, 1961.

KEY: Sukh1961

- [308] Elias Symeonakis, Tim Robinson, and Nick Drake. GIS and multiple-criteria evaluation for the optimisation of tsetse fly eradication programmes. *Environmental Monitoring and Assessment*, 124(1-3):89–103, January 2007.

KEY: SymeEtAl2007

ANNOTATION: Tsetse flies are the vectors of trypanosomes, the causal agent of trypanosomiasis, a widespread disease of livestock and people in Africa. Control of tsetse may open vast areas of land to livestock-keeping, with the associated benefits of developing mixed crop-livestock production systems. However, as well as possible positive impacts there are also risks: bush clearing would accelerate and cattle numbers would rise, leading to a reduction of vegetation cover, and an increase in runoff and erosion; there may also be increased pressure on conserved areas and reductions in biodiversity. The objective of this study is to show how remotely sensed and other environmental data can be combined in a decision support system to help inform tsetse control programmes in a manner that could be used to limit possible detrimental effects of tsetse control. For Zambia, a methodology is developed that combines a tree-based decision-support approach with the use of Multiple-Criteria Evaluation (MCE), within a Geographical Information System (GIS), in order to target areas for tsetse control. The results show clear differentiation of priority areas under a series of hypothetical scenarios, and some areas (e.g. northwest of Petauke in the Eastern Province of Zambia) are consistently flagged as high priority for control. It is also demonstrated that priority areas do not comprise isolated tsetse populations, meaning that disease control using an integrated approach is likely to be more economically viable than local eradication.

- [309] Tiku T Tanyimboh and Paul Kalungi. Optimal long-term design, rehabilitation and upgrading of water distribution networks. *Engineering Optimization*, 40(7):637–654, July 2008.

KEY: TanyKalu2008

ANNOTATION: Given a limited budget, the choice of the best water distribution network upgrading strategy is a complex optimization problem. A model for the optimal long-term design and upgrading of new and existing water distribution networks is presented. A key strength of the methodology is the use of maximum entropy flows, which reduces the size of the problem and enables the application of linear programming for pipe size optimization. It also ensures the reliability level is high. The capital and maintenance costs and hydraulic performance are considered simultaneously for a predefined design horizon. The timing of upgrading over the entire planning horizon is obtained by dynamic programming. The deterioration over time of the structural integrity and hydraulic capacity of every pipe are explicitly considered. The upgrading options considered include pipe paralleling and replacement. The effectiveness of the model is demonstrated using the water supply network of Wobulenzi town in Uganda.

- [310] Mehreteab Tesfai and Silke Drescher. Assessment of benefits and risks of landfill materials for agriculture in Eritrea. *Waste Management*, 29(2):851 – 858, 2009.
KEY: TesfDres2009
ANNOTATION: In Eritrea, farmers have applied landfill materials as fertiliser to their fields for several decades. A sampling scheme in the landfill site of Asmara and selected farmers' fields was carried out to investigate the benefits and risks of using landfill materials for agriculture. Soil samples were collected from farmers' fields (7 samples) and from the Asmara landfill site (12 samples). The samples were analysed for major plant nutrients, heavy metals (Cd, Cr, Cu, Pb, Ni, Hg and Zn), and some physical properties. Nearly 65% (by weight) of the total landfill material mined from the landfill site constituted waste fractions of various substances. The remaining 35% was composed of soil-like materials, which are apparently used to fertilise agricultural soils. The average organic matter, total nitrogen, and available phosphorus contents of soils with landfill material measured 2.4%, 0.13%, and 45 mg kg⁻¹, respectively. However, soils without landfill material consisted of 1.1 % organic matter, 0.04% total N, and < 40 mg kg⁻¹ of available P. Except for Hg, all the other heavy metals in the landfill site showed values above the permissible limits. In particular, the average concentrations of Cu (913 mg kg⁻¹) and Pb (598 mg kg⁻¹) in the landfill site were nine-fold and four-fold greater than the allowable limits, respectively. It is, therefore, suggested that composting fresh organic wastes should be considered and tested as an alternative material for fertilising agricultural soils and to maintain the quality of the environment.
- [311] P H Thangata, P E Hildebrand, and C.H Gladwin. Modeling agroforestry adoption and household decision making in Malawi. *African Urban Quarterly*, 6(1-2):249–268, 2002.
KEY: ThanEtAl2002a
ANNOTATION: Low resource farmers make decisions about adopting new technologies as part of the overall strategy for ensuring subsistence and cash income for their food security needs. This paper reports on a study conducted in Kasungu, Malawi, southern Africa, to evaluate the potential for small-scale farmers to adopt improved fallows. Simulations of two representative households, a male and a female headed, were carried out using dynamic ethnographic linear programming in a ten-year model. Results show that the adoption pattern for improved fallows is driven by the amount of land and labor available rather than the gender of the household head. Female-headed households with insufficient labor may hire labor for other cropping activities, which enables them to plant improved fallows. Furthermore, simulations show that when households are able to sell seed from the woody species in the fallow, both male and female households stop taking credit for fertilizer for their cash crop. They still grow the cash crop, in this case tobacco, but produce most of their maize without chemical fertilizers. It is concluded that in Kasungu, Malawi, improved fallows will be adopted in households with sufficient land and labor.
- [312] P H Thangata, P E Hildebrand, and F Kwesiga. Predicted impact of HIV/AIDS on improved fallow adoption and rural household food security in Malawi. *Sustainable Development*, 15(4):205–215, 2007.
KEY: ThanEtAl2007
ANNOTATION: Research was conducted to assess the impact of HIV/AIDS on improved fallow adoption and rural household food security in Malawi. An ethnographic linear programming model was created for a representative household with three scenarios: no illness, adult female illness and adult male illness. Results show that the impact of HIV/AIDS on food production depends on the patient's gender. If a male head of household is sick and later dies, available field labour is reduced as family members are expected to care for him and, consequently, less food and cash crops are produced, which creates a food insecure household. However, when a woman is sick and later dies, the effect on male labour is not as great, as males are not care-givers. We conclude that in an HIV/AIDS environment, agroforestry adoption is more feasible in households in which available labour is undisturbed for longer periods of time.
- [313] P K Thornton and M Herrero. Integrated crop-livestock simulation models for scenario analysis and impact assessment. *Agricultural Systems*, 70(2-3):581–602, November-December 2001.
KEY: ThorHerr2001
ANNOTATION: Despite the fact that many smallholder farming systems in developing countries revolve around the interactions of crop and livestock enterprises, the modelling of these systems using combinations of detailed crop and livestock models is comparatively under-developed. A wide variety of separate crop and livestock models exists, but the nature of crop livestock interactions, and their importance in smallholder farming systems, makes their integration difficult. Even where there is adequate understanding of the biophysical processes involved, integrated crop livestock models may be constrained by lack of reliable data for calibration and validation. The construction

from scratch of simulation models that meet the needs of one particular case is generally too costly to countenance. As for all modelling activity, the most efficient way to proceed depends on the nature of the systems under study and the precise questions that have to be addressed. We outline a framework for the integration of detailed biophysical crop and livestock simulation models. We highlight the need for minimum calibration and validation data sets, and conclude by listing various research problems that need attention. The application of robust and trustworthy crop-livestock models is critical for furthering the research agenda associated with animal agriculture in the tropics and subtropics.

- [314] Colin Thunhurst. The use of problem structuring methods in strategic health planning. *International Transactions in Operational Research*, 10(4):381–392, July 2003.

KEY: Thun2003

ANNOTATION: Problem structuring methods have emerged as a powerful weapon in the armoury of operational research over the past twenty years. This paper will present and discuss the value of adopting formal problem structuring methods as part of the strategic health planning process. It will outline how problem structuring methods were embedded into the strategic health planning system developed for provincial health planning in Pakistan. It will draw upon the author's recent experience of using this system to assist the Government of the North West Frontier Province of Pakistan to develop a 'Master' Health Plan for the Federally Administered Tribal Areas of Pakistan. It will discuss the systematic use of problem structuring methods in the District Implementation Planning Process in Malawi. It will consider the value of adopting similar methods in developed health systems, particularly their role in bridging the gap in a 'partnership model' between community groups and statutory decision-makers.

- [315] A Tibaijuka. The cost of differential gender roles in African agriculture: a case study of smallholder banana-coffee farms in the Kagera region, Tanzania. *Journal of Agricultural Economics*, 45(1):69–81, 1994.

KEY: Tiba1994

ANNOTATION: In 1982/83, due to either economic pressure or profit motivation, 30% of the men in a random sample of 200 smallholder banana-coffee farms in the Kagera region of Tanzania had adopted a more liberalised division of labour, and engaged in operations and horticultural farm enterprises that traditionally are the responsibility of women. A linear programming model is used to estimate the impact of gender roles on farm incomes and resource productivity among the sample. The results suggest that by liberalising sex roles, cash incomes could increase by up to 10% while the productivity of labour and capital would improve by 15% and 44% respectively. In view of the economic benefits to be reaped, it is recommended that, within the framework of economic adjustment, African governments should launch campaigns to enhance this process because gender roles impair efficiency.

- [316] P Tittonell, M T van Wijk, M C Rufino, J A Vrugt, and K E Giller. Analysing trade-offs in resource and labour allocation by smallholder farmers using inverse modelling techniques: A case-study from Kakamega district, western Kenya. *Agricultural Systems*, 95(1-3):76–95, 2007.

KEY: TittEtAl2007

ANNOTATION: Smallholder farms in sub-Saharan Africa face multiple trade-offs when deciding on the allocation of their financial, labour and nutrient resources. Day-to-day decisions have implications for the sustainability of their farming system, implying multiple trade-offs between short- and long-term objectives that have biophysical and socio-economic dimensions. We show that inverse modelling techniques can be used effectively for optimisation and trade-offs analysis of farming systems. By combining the multi-objective shuffled complex evolution metropolis algorithm and a crop/soil dynamic simulation model we were able to select farming strategies that resulted in the best possible trade-offs between different farming objectives. This integrated analytical tool allows optimisation of farmers' goals similar to linear programming, but an advantage over linear programming is that the proposed method takes into account a wider spectrum of biophysical processes including their interactions and feedbacks. Tradeoffs between resource productivity, use efficiency and conservation in relation to different patterns of resource allocation were analysed for a maize-based, simplified case study farm from western Kenya (2.2 ha — comprising fields of poor, medium and high soil fertility), under three scenarios of financial liquidity to invest in labour and inputs (2000, 5000 and 10,000 KSh ha⁻¹; 75 KSh = 1 USDollar). The maximum farm-scale maize production achieved was larger when financial resources increased. However, increasing maize yields above a certain threshold by applying mineral fertilisers was associated with larger N losses by leaching, runoff and soil erosion; such threshold was 2.7 t grain ha⁻¹ for the scenario of no financial limitations (10,000 KSh ha⁻¹). N losses at farm scale fluctuated between

36 and 54 kg N ha⁻¹ season-1, while the maximum maize yields achieved were around 3.4 t grain ha⁻¹. Soil losses by erosion increased abruptly beyond a certain maize yield (e.g. 1.8 t grain ha⁻¹ for the 2000 KSh ha⁻¹ scenario), while the minimum rate of soil loss differed between financial scenarios. Investments in hiring labour were prioritised over fertiliser use to obtain the greatest yields and the allocation of available resources favoured the more fertile fields. This inverse modelling exercise allowed us to analyse trade-offs between different farmers' objectives and to compare potential resource allocation strategies to achieve them. The set of strategies to achieve different goals was more numerous and variable when the conditions were less conducive for farming. This questions the validity of the prevailing model of extension/communication, based on generalised recommendations for resource-poor farmers in Africa.

- [317] A.E. Ubogu, J.A. Ariyo, and M. Mamman. Port-hinterland trucking constraints in Nigeria. *Journal of Transport Geography*, 19(1):106–114, 2011.

KEY: Ubogu2011106

- [318] Martin Upton and Harold Casey. Problems in planning tropical tree crop projects and possible solutions. *Oxford Agrarian Studies*, 3(2):89–100, 1974.

KEY: UptoCase1974

ANNOTATION: There are three basic approaches to replanting a tropical tree crop that is being maintained as a long-term project. These are: (a) replacement of individual trees as they reach the end of their economic life; (b) total replacemnet of the whole area as it reaches the end of its economic life; (c) continuous replacement of a given proportion of trees each year. The decision about which is best is linked to questions of the capacity of the processing plant, and local employment. This paper uses dynamic programming to investigate the three approaches. There is no case study, but the authors refer to problems of coffee beans in Kenya, oil palm and rubber in Nigeria, and limes in Montserrat.

- [319] F van den Berghy, J P Holloway, M Pienaar, R Koen, C D Elphinstone, and S Woodborne. A comparison of various modelling approaches applied to cholera case data. *ORiON*, 24(1):17–36, January 2008.

KEY: BergEtAl2008

ANNOTATION: The application of a methodology that proposes the use of spectral methods to inform the development of statistical forecasting models for cholera case data is explored in this paper. The seasonal behaviour of the target variable (cholera cases) is analysed using singular spectrum analysis followed by spectrum estimation using the maximum entropy method. This seasonal behaviour is compared to that of environmental variables (rainfall and temperature). The spectral analysis is refined by means of a cross-wavelet technique, which is used to compute lead times for co-varying variables, and suggests transformations that enhance co-varying behaviour. Several statistical modelling techniques, including generalised linear models, ARIMA time series modelling, and dynamic regression are investigated for the purpose of developing a cholera cases forecast model fed by environmental variables. The analyses are demonstrated on data collected from Beira, Mozambique. Dynamic regression was found to be the preferred forecasting method for this data set.

- [320] Richard van den Broek and Lex Lemmens. Rural electrification in Tanzania: Constructive use of project appraisal. *Energy Policy*, 25(1):43 – 54, 1997.

KEY: BroeLemm1997

ANNOTATION: Three ways of evaluating rural electrification projects are described: the financial appraisal, the economic appraisal and the socioeconomic appraisal. These appraisals are respectively from the point of view of the electric utility, the national income and the national welfare. Past experiences with project appraisal in Tanzania are critically assessed. A methodological framework for improved project appraisal is presented with emphasis on socioeconomic benefit measurement. The three types of appraisal are applied in a constructive way to a Tanzanian case. Measures are formulated to solve the main bottlenecks, being ineffective electricity tariffs and low power factors.

- [321] A Verdoodt and E van Rans. Environmental assessment tools for multi-scale land resources information systems - a case study of Rwanda. *Agriculture Ecosystems and Environment*, 114(2-4):170–184, June 2006.

KEY: VerdRans2006

ANNOTATION: Sustainable land use planning involves both policy- and farmer-oriented agricultural land use strategies. In this paper, a spatially and temporally explicit multi-scale decision support system that reveals the biophysical indicators affecting land use choices of these different stakeholders, is explained and demonstrated. It comprises three different environmental assessment tools, designed to run with data supplied by traditional soil surveys and organised into a land resources information system. A qualitative land suitability classification procedure is adapted to translate

the large-scale biophysical data supplied by a reconnaissance soil survey, into five suitability classes. At local scale, the productivity of the soil units identified during the semi-detailed soil survey is estimated using a three-level hierarchical crop productivity estimator, simulating the potential, water-limited and land production potential. At the smallest spatial and temporal resolution, a daily water balance approach is linked to a crop growth model, using daily climatic data recorded at different meteorological stations and the description, physical and chemical analyses of the soil profiles. The decision support system was applied and validated using the land resources information system of Rwanda. The system was capable to reveal the biophysical properties affecting crop regionalisation at national and local scale. Yield gaps between the potential, water-limited and land production potential, identified options for productivity optimisation such as irrigation or fertilisation. The crop growth model illustrated the delicate equilibrium between sowing date, crop cycle length and the length of the rainy seasons, limiting options for intensification. Combination of a multi-scale nature with scale-specific environmental assessment tools thus proved successful in identifying the different driving forces affecting land use choices made by different stakeholders involved, ranging from agricultural policy makers to individual farmers. This comprehensive approach is essential to realistic and sustainable land use planning.

- [322] I T Vieira, Paul R Harper, Arjan K Shahani, and V de Senna. Mother-to-child transmission of HIV: a simulation-based approach for the evaluation of intervention strategies. *Journal of the Operational Research Society*, 54(7):713–722, July 2003.

KEY: VierEtAl2003

ANNOTATION: Mother-to-child transmission (MTCT) of HIV is the most significant source of HIV infection in children below the age of 15 years. In 2000 alone, about 600 000 new infections occurred, the vast majority from mothers living in developing countries who were not aware of their HIV-positive status. To date, at least 4.3 million children have died from AIDS. In this paper, we discuss the development of an operational model that can be used to evaluate intervention options for the prevention of MTCT of HIV. The problem was approached by defining suitable pregnancy risk groups, prevention options and the required model outputs to evaluate different intervention strategies. The method chosen to approach the problem was a discrete-event, three-phase simulation, built in Visual Basic, with a stochastic semi-Markov structure. The developed model takes individual pregnant women through each stage of their pregnancy, labour and birth. Different intervention strategies may be modelled at any time, including short-course antiretroviral drugs and cessation of breastfeeding. The model is demonstrated with data from Botswana, which has one of the highest HIV-infection rates in the world.

- [323] W van Vuuren and J G Hamilton. The payoff of developing a small-scale phosphate mine and beneficiating operation in the Mbeya region of Tanzania. *World Development*, 20(6):907 – 918, 1992.

KEY: VuurHami1992

ANNOTATION: This study investigates the financial and economic viability of developing a small-scale phosphate mine and beneficiating operation for the distribution of rock phosphate to be used as a direct-application fertilizer by farmers in the Mbeya region of Tanzania. Local production of phosphate fertilizer would reduce both fertilizer shortages and foreign currency requirements through import substitution. It would also benefit the local economy by providing employment in the mining and beneficiating operation. Calculations based on preliminary data show that the development of the project would be highly beneficial for farmers, for the local economy of the region, and for the nation.

- [324] L.W.I. Wairegi and P.J.A. van Asten. The agronomic and economic benefits of fertilizer and mulch use in highland banana systems in Uganda. *Agricultural Systems*, 103(8):543–550, 2010.

KEY: WairAste2010

ANNOTATION: Banana is the most important food crop in Uganda. However, there has been a decline in productivity, attributed to declining soil fertility, drought, pests and diseases and crop management factors. This study aimed to explore the possibility of increasing yields through the use of fertilizer and mulch, and to evaluate the benefits of these inputs across the major banana producing regions in Uganda. This study was carried out in 179 smallholder plots in Central, South, Southwest and East Uganda in 2006/7. Half of the plots were [']demonstration plots' of an agricultural development project, while the other half were neighboring farmer plots that acted as [']control'. Demonstration plots received mineral fertilizer (100% of plots), averaging 71 N, 8 P, 32 Kkg/ha-1yr-1 and external mulch from grass and crop residues (64% of plots), whereas control plots received no mineral fertilizer and little external mulch (26% of plots). Demonstration

plots had significantly ($P \leq 0.05$) higher yields than control plot in Central, South and Southwest, but average yield increases varied from 4.8 t ha⁻¹ (Southwest) to 8.0 (Central), and 10.0 (South). Average weevil corm damage (3%) and nematode-induced root necrosis (7%) was low and similar for both plot types, so yield increases could only be explained by the use of fertilizer and mulch. The highest demonstration plot yield increases were observed where fertilizer addressed key nutrient deficiencies identified using the compositional nutrient diagnosis approach. Farm gate bunch prices declined from 0.17 (Central Uganda) to 0.07 USD kg⁻¹ (Southwest Uganda). Consequently, average marginal rate of return (MRR) of fertilizer and mulch use ranged from 0.1 (Southwest) to 5.8 (Central). The technologies were likely to be acceptable to farmers (MRR ≥ 1.00) up to 160 km away from the capital. Fertilizer use is likely to be acceptable in all regions (MRR = 0.7–9.4) if local fertilizer prices of 2006/7 (average USD 0.56 kg⁻¹ of fertilizer) declined by 50%. Fertilizer prices are likely to make fertilizer use unacceptable beyond 100 km away from the capital. The study concludes that there is scope for increased input use in banana systems in Uganda, but that regional variations in crop response, input/output prices, and price fluctuations have to be taken into account.

- [325] M M Waithaka, P K Thornton, M Herrero, and K D Shepherd. Bio-economic evaluation of farmers' perceptions of viable farms in western Kenya. *Agricultural Systems*, 90(1-3):243–271, October 2006.

KEY: WaitEtAl2006

- [326] A Walker, M van Noordwijk, and G Cadisch. Modelling of planted legume fallows in western Kenya. (ii) productivity and sustainability of simulated management strategies. *Agroforestry Systems*, 74(2):143–154, October 2008.

KEY: WalkEtAl2008

ANNOTATION: Improved fallow is a technology that can help to raise agricultural productivity in systems of poor soil fertility and low financial capital. Models, once calibrated, can be used to investigate a range of improved fallow systems relatively quickly and at relatively low cost, helping to direct experimental research towards promising areas of interest. Six fallow crop rotations were simulated using the WaNuLCAS model in a bimodal rainfall setting in Kenya over a 10 year period: (A) alternating fallow and crop seasons, (B) one season fallow followed by three seasons crop, (C) one season fallow followed by four seasons crop, (DF) 13 seasons fallow periods followed by 35 seasons crop. The strategies were tested using a number of fallow growth rates, soil clay contents, and rainfall amounts to determine the interaction of fallow rotation and biophysical variables on maize (*Zea mays* (L.)) yield and sustainability (organic matter, N₂ fixation, leaching). The best simulated fallow strategies doubled maize yield compared to continuous maize over a 10 year period. Across all biophysical treatments strategy A and B of no more than three consecutive cropping seasons and of one consecutive fallow season yielded the most maize. This was because fallow benefits were largely due to the immediate fallow soil fertility benefit (IFB) rather than the cumulative benefit (CFB). The difference in yield between the two strategies was through a balance between (1) their interaction with the biophysical variables affecting accumulation of organic matter, hence increasing soil fertility and (2) the extra intrinsic soil fertility used for maize productivity by the inclusion of more cropping seasons within the rotation. We propose the following conceptual framework to manage fallows for maximum maize yield: when environmental factors are strongly limiting to fallow and crop growth then fallow strategy A would be the best strategy to employ (less risk but more labour) and when factors are less limiting then strategy B would be the best to employ.

- [327] Geoff Walsham. Telephone systems in the third world: A research project. *Journal of the Operational Research Society*, 34(3):225–231, March 1983.

KEY: Wals1983

ANNOTATION: Potential users of the telephone in the Third World are often frustrated by lack of good access to the system or by its poor performance in terms of call delays. A research project has been carried out for a period of over three years addressed to the management of this *mess*. The field work took place in Kenya and included a major survey of telephone users in two regions. Models have been developed in the areas of regional demand and corporate policy but it is argued that these are not necessarily the major contributors to the primary goal of increased understanding. The article describes the context of the research, gives an outline of the work which has been carried out and discusses implementation. Some inferences are drawn on the usefulness of O.R. in the Third World and on research into *messes*.

- [328] R Walters. Crime, bio-agriculture and the exploitation of hunger. *British Journal of Criminology*, 46(1):26–45, 2006.

KEY: Walt2006

ANNOTATION: The rapid expansion of biotechnology during the past decade has created widespread

debate and concern within the agricultural sector and consumer groups. This article examines the monopolization of bio-technology and the political economy of genetically modified food. It further explores the ways that powerful governments and corporations seek to dominate global food markets whilst exploiting, pressuring and threatening vulnerable countries. In doing so, it provides a detailed examination of Zambia, which has experienced significant political and economic pressure from Western governments and corporations to accept genetically modified maize. Finally, it explores 'eco-crime' within frameworks of state and corporate crime, international environmental law and emerging discourses in green criminology.

- [329] W A Welderufael and Y E Woyessa. Evaluation of surface water drainage systems for cropping in the Central Highlands of Ethiopia. *Agricultural Water Management*, 96(11):1667 – 1672, 2009.

KEY: WeldWoye2009

ANNOTATION: In Ethiopia vertisols cover about 10% of the total land area and is the fourth most important soil used for crop production, accounting for nearly 23% of the total arable land used for crop production. More than half of the vertisols are found in the Central Highlands of Ethiopia, with an altitude of more than 1500 m above mean sea level. The unique physical and chemical properties of these soils and the high rainfall during the main cropping season create severe surface waterlogging problems which hinder crop production activities. Severe surface waterlogging affects the growth of plants by impeding nutrient uptake and creating oxygen deficiency around the root zone. To address this crop production problem, three surface water drainage methods, namely broad bed and furrow (BBF), ditch, and flat (traditional) methods were evaluated using the water balance of the plant root zone and wheat as a test crop. The experiment was conducted at the Ginchi Research Station in the central highlands of Ethiopia over two consecutive seasons (2000 and 2001). The results showed that both the BBF and the ditch drainage methods gave about 33% and 22% more grain yield than the flat treatment, respectively. However, there were no significant differences between BBF and ditch for both grain and biomass yield during both experimental seasons. During both seasons the total water balance (Δ_{W_r}) at the root zone especially, in the months of June, July and August on all the treatments was higher than the crop water requirement (ETc) and showed no significant difference between the treatments. Thus, the results of this study indicated that the soil water in the root zone was not significantly altered by surface drainage systems and therefore implies the need of further improvement of the different surface drainage methods regarding improving the waterlogging condition and hence the productivity of the vertisols in the Central Highlands of Ethiopia.

- [330] T Whalen and Daniel Pollack. Decision tools to benefit children needing adoption. *Human Systems Management*, 26:35–45, 2007.

KEY: WhalPoll2007

ANNOTATION: Millions of children worldwide need permanent families. But traditional paper based methods, disagreements between agencies, and excessive nationalistic restrictions keep many children apart from potential parents able and eager to nurture them. This paper focuses on the use of Weighted Ordered Weighted Averages and linear assignment programming for matching orphaned or abandoned children with adoptive families. Traditional paper based, one-child-at-a-time approaches are slow, and speed matters, because of the well documented harm done when children spend too much time waiting. Our focus is on simultaneous matching in which a pool of potential families is viewed as a resource to be used of the benefit for a pool of children in a global way rather than one at a time. A special case of the Weighted Ordered Weighted Average, designed to be transparent to social workers with little or no mathematical training or inclination, is used to aggregate criteria. The United States Department of Health and Human Services estimates that over 500,000 children are in foster care with 130,000 available for adoption. In sub-Saharan Africa, Asia, Latin America, and the Caribbean, a joint report by the UN/AIDS/UNICEF/USAID estimates that in 2003 there were 143 million orphans. Negative experiences with the foster care system also lead to more children available for adoption. Furthermore, with the rapid increase in drug dependency, AIDS, child maltreatment, and homelessness, the number of children available for adoption increases concomitantly. It is universally agreed that a more efficient and swifter system needs to be developed in order to place these children in permanent homes. This paper focuses on the use of Weighted Ordered Weighted Averages and linear assignment programming for matching orphaned or abandoned children with adoptive families. We begin by reviewing traditional paper based, one-child-at-a-time approaches using unaided human judgment or human judgment aided by semi-automated systems for preliminary screening and short-listing. The primary focus is on simultaneous matching in which a pool of potential families is viewed as a resource to be used for

the benefit of a pool of children in a global way rather than one at a time. A special case of the Weighted Ordered Weighted Average, designed to be transparent to social workers with little or no mathematical training or inclination, is used to aggregate criteria.

- [331] Martin Wiese, I Yosko, and M Donnat. La cartographie participative en milieu nomade: un outil d'aide à la décision en Santé publique—étude de cas chez les Dazagada du Bahr-el-Ghazal (Tchad). (Participatory mapping as a tool for public health decision-making in nomadic settings. A case study among Dazagada pastoralists of the Bahr-el-Ghazal region in Chad.). *Med Trop (Mars)*, 64(5):452–463, 2004.

KEY: WiesEtAl2004

ANNOTATION: Integrating the strategies of the point of view of nomadic breeders of cattle into a geographic information system (GIS) highlights the complexity of the temporospatial context associated with point of view of finding health care seeking by nomadic pastoralists. The method used in this study was based on a combination of participatory mapping with group discussions and semi-structured interviews. The resulting data allowed georeferencing of the pastoral environment in the inner Lake Chad Basin according to the representation of Dazagada pastoralists of the Bahr-el-Ghazal region (Kanem, Tchad). By providing better insight into the day-to-day life of nomadic people determining their capacities to make use of primary health care, this holistic approach provides a tool to assist public health decision-makers in optimizing the use of health care facilities by nomadic communities.

- [332] David S Wilkie, B Curran, R Tshombe, and G A Morelli. Modeling the sustainability of subsistence farming and hunting in the Ituri forest of Zaire. *Conservation Biology*, 12(1):137–147, February 1998.

KEY: WilkEtAl1998

ANNOTATION: We used empirical data to simulate the impacts, over the next 40 years, of subsistence-level agricultural clearing and bushmeat consumption on forest resources within the recently established Okapi Wildlife Reserve in northeastern Zaire. Satellite imagery, human population census data, and field measurements were used to calculate Present and projected impacts of agricultural clearing on forest cover: Data on per capita meat consumption and the species captured by hunters were combined with relevant ecological data to estimate ratios of consumption to production and to assess the sustainability of hunting. Even with projected population growth of nearly 300% among local communities over 40 years, sufficient secondary forest is available that agricultural clearing will have minimal effect on mature forest throughout most of the reserve. Impacts on the reserve's fauna will be more dramatic particularly within 15 km of villages where most hunting currently occurs. Subsistence exploitation of forest antelopes may be sustainable in much of the reserve (especially if high estimates of game production are used), but as the human Population continues to increase duikers will likely be over-hunted. Primate populations do not appear to be threatened. In the near future in those areas where bow hunters exploit monkeys, but an increase in this specialized activity in other regions of the reserve and growing human populations could change this. Although additional surveys of commonly hunted species throughout the Okapi wildlife Reserve are essential to enhancing the precision of the simulation, our results suggest that mitigation efforts should be designed and implemented to note if the long-term effects of domestic bushmeat consumption are to be addressed.

- [333] David S Wilkie and John T Finn. A spatial model of land use and forest regeneration in the Ituri forest of northeastern Zaire. *Ecological Modelling*, 41(3-4):307 – 323, 1988.

KEY: WilkFinn1988

ANNOTATION: A model of land-use change in the Ituri tropical moist forest of Zaire was developed to examine the changes in forest structure brought on by the recent concentration of formerly dispersed horticulturalist villages along a road. This cell-space model uses eight land-use categories: road, village, active shamba (field), farm-bush, Musanga forest, old seral forest, climax forest and forest islands. The model consists of two main parts: forest succession and shamba selection. Forest succession is determined deterministically by time since cultivation. Climax forest returns to the open ['farm-bush' class with a probability of 0.0025 per year. Shamba selection for each village involves the age of a cell, travel time to the cell from the village, and whether the cell is in the village's usufruct. A usufruct is the territory a village holds in trust for future generations. Productivity of each site is a function of the number of years fallow allowed. Simulations using various parameter combinations were done starting in 1940 (the approximate time of road construction), and lasting from 45 to 250 years. Corroboration of the model was done by comparing model results with transects of vegetation types taken in 1983 and Landsat imagery from 1985. For the situation with no population growth, the model predicts a more open habitat near the road, but able to support the villages indefinitely. With 5area near the road is converted almost

entirely to farm-bush and Musanga forest in 45 years, productivity of the shambas is decreased, and the area must be abandoned after about 80 years.

- [334] Justin C Williams. Delineating protected wildlife corridors with multi-objective programming. *Journal Environmental Modeling and Assessment*, 3(1–2):77–86, March 1998.

KEY: Will1998

ANNOTATION: Protected wildlife corridors can help counteract habitat fragmentation and link isolated reserve ‘islands’ into connected reserve systems. The need for wildlife corridors will grow as expanding human populations place increasing pressure on remaining undeveloped land. A two-objective zero-one programming model is formulated for the problem of selecting land for a system of wildlife corridors that must connect a known set of existing reserves or critical habitat areas. This problem is modeled as a network Steiner tree problem, under the objectives of minimizing corridor land costs and minimizing the amount of unsuitable land within the corridor system. Linear programming is used to find exact solutions with little or no branching and bounding, and the multi-objective weighting method is used to generate nondominant alternatives. Two hypothetical examples demonstrate the model and solution procedure. Results can help inform planning and decision making for protected area land acquisition and habitat restoration.

- [335] A Winter-Nelson. Marketing natural products and the development of synthetic substitutes: A Kenyan example. *Journal of African Economies*, 5(3):469–496, 1996.

KEY: Wint1996

ANNOTATION: Adverse changes in terms of trade are generally viewed as an external cause of economic decline in Africa. However, in some instances export price shocks are not exogenous to domestic policy. When the entry of synthetic substitute producers is a function of the price of the natural product, raw material export levels can induce entry and cause shifts in demand. This paper examines the market for Kenyan pyrethrum (a natural insecticide) and develops a dynamic programming model for determining export strategy when the current export price induces structural changes in demand. Analysis of the pyrethrum market over the 1963-90 period suggests that the use of this analytical method could have mitigated the loss of market share to synthetics after 1980. The policy prescribed by the dynamic model would increase the exporter’s net revenues by almost 30% compared with the policy indicated by analysis that treats demand as exogenous. In fact, the value of Kenyan pyrethrum exports from 1981-86 averaged 36% below the 1976-80 value.

- [336] W T Wiskerke, V Dornburg, C D K Rubanza, R E Malimbwi, and A P C Faaij. Cost/benefit analysis of biomass energy supply options for rural smallholders in the semi-arid eastern part of Shinyanga Region in Tanzania. *Renewable and Sustainable Energy Reviews*, 14(1):148 – 165, 2010.

KEY: WiskEtAl2010

ANNOTATION: This study analyzes the economic feasibility of sustainable smallholder bio-energy production under semi-arid conditions. The eastern part of Shinyanga region in Tanzania was chosen as a case study area. Three different sustainable biomass energy supply systems were compared by means of cost/benefit analysis: a small-scale forestation project for carbon sequestration, a short rotation woodlot and a *Jatropha* plantation, thereby using the produced *Jatropha* oil as a substitute for fuelwood or diesel. Rotational woodlots are most profitable with a Net Present Value of up to US\$2007 1165/ha, a return on labour of up to US\$2007 6.69/man-day and a fuelwood production cost of US\$2007 0.53/GJ, compared to a local market price of US\$2007 1.95/GJ. With a production cost of US\$2007 19.60/GJ, *Jatropha* oil is too expensive to be used as an alternative for fuelwood. Instead it can be utilized economically as a diesel substitute, at an observed diesel cost of US\$2007 1.49/l. The mean annual biomass increment (MAI) in semi-arid East Shinyanga is too low to collect sufficient benefits from trading forestation carbon credits under the Clean Development Mechanism (CDM) to cover the costs of forestation and forest management.

- [337] Eva Wollenberg, David Edmunds, and Louise Buck. Using scenarios to make decisions about the future: anticipatory learning for the adaptive co-management of community forests. *Landscape and Urban Planning*, 47(1-2):65 – 77, 2000.

KEY: WollEtAl2000

ANNOTATION: Current trends to improve the adaptiveness of community forest management focus on monitoring past actions and emphasize internal dynamics. We show how scenario methods can be used to (1) enable managers to better understand landscape and larger scale forces for change and to work with stakeholders at these levels and (2) improve adaptiveness not only by responding to changes, but also by anticipating them. We review methods related to scenario analysis and discuss how they can be adapted to community management settings to improve the responsiveness and the collaboration among stakeholders. The review is used to identify the key elements of scenario methods that CIFOR will test among communities in Bulungan Regency,

East Kalimantan, Indonesia and two villages in the buffer zone of Ranomafana National Park, Madagascar.

- [338] Wei Xiong, Nathaniel Hupert, Eric B Hollingsworth, Megan E O'Brien, Jessica Fast, and William R Rodriguez. Can modeling of HIV treatment processes improve outcomes? Capitalizing on an operations research approach to the global pandemic. *BMC Health Services Research*, 8(166):10 pages, accessed 26:October:2010, August 2008.

KEY: XionEtAl2008

ANNOTATION: Background: Mathematical modeling has been applied to a range of policy-level decisions on resource allocation for HIV care and treatment. We describe the application of classic operations research (OR) techniques to address logistical and resource management challenges in HIV treatment scale-up activities in resource-limited countries. Methods We review and categorize several of the major logistical and operational problems encountered over the last decade in the global scale-up of HIV care and antiretroviral treatment for people with AIDS. While there are unique features of HIV care and treatment that pose significant challenges to effective modeling and service improvement, we identify several analogous OR-based solutions that have been developed in the service, industrial, and health sectors. Results: HIV treatment scale-up includes many processes that are amenable to mathematical and simulation modeling, including forecasting future demand for services; locating and sizing facilities for maximal efficiency; and determining optimal staffing levels at clinical centers. Optimization of clinical and logistical processes through modeling may improve outcomes, but successful OR-based interventions will require contextualization of response strategies, including appreciation of both existing health care systems and limitations in local health workforces. Conclusion: The modeling techniques developed in the engineering field of operations research have wide potential application to the variety of logistical problems encountered in HIV treatment scale-up in resource-limited settings. Increasing the number of cross-disciplinary collaborations between engineering and public health will help speed the appropriate development and application of these tools.

- [339] Michael Yhdego, Rene V V Vidal, and Christian M Overgaard. Planning of disposal sites in Dar es Salaam, Tanzania—a decision support system approach. *Waste Management Research*, 10(2):141–152, 1992.

KEY: YhdeEtAl1992

ANNOTATION: A system is developed aiming at supporting the planners in several aspects of solid waste management in developing countries. The system is tailored especially to planning of disposal sites in Dar es Salaam, Tanzania based on a decision support system framework. Emphasis was placed on: applicability for users without particular computer knowledge, a simple and comprehensible system for solid waste planners to use, stressing environmental impact, and introduction of subjective judgements. As an important element of problem formulation and problem solving, the involved decision processes are elaborated. The entire system is implemented within a Lotus 1-2-3 spreadsheet environment. The developed model illustrates that it is possible to include and emphasize several features that are lacking in many existing commercial computerized models.

- [340] J M Yilma and J B Malone. A geographic information system forecast model for strategic control of fasciolosis in Ethiopia. *Veterinary Parasitology*, 78(2):103 – 127, 1998.

KEY: YilmMalo1998

ANNOTATION: A geographic information system (GIS) forecast model based on moisture and thermal regime was developed to assess the risk of *Fasciola hepatica* or liver fluke, a temperate species, and its tropical counterpart, *Fasciola gigantica*, in Ethiopia. Agroecological map zones and corresponding environmental features that control the distribution and abundance of the disease and its snail intermediate hosts were imported from the Food and Agriculture Organization (FAO) Crop Production System Zones (CPSZ) database on east Africa and used to construct a GIS using ATLAS GIS 3.0 software. Base temperatures of 10°C and 16°C were used for *F. hepatica* and *F. gigantica*, respectively, to calculate growing degree days in a previously developed climate forecast system that was modified to allow use of monthly climate data values. The model was validated by comparison of risk indices and environmental features to available survey data on fasciolosis. Monthly Fasciola risk indices of four climatic regions in Ethiopia were used to project infection transmission patterns under varying climatic conditions and strategic chemotherapeutic fasciolosis control schemes. Varying degrees of *F. hepatica* risk occurred in most parts of the country and distinct regional *F. hepatica* transmission patterns could be identified. In the humid west, cercariae-shedding was predicted to occur from May to October. In the south it occurred from April to May and September to October, depending on the annual abundance of rain. In the north-central and central regions, risk was highest during heavy summer rains and pasture contamination with metacercariae was predicted to occur during August-September, except in wet

years, when it may start as early as July and extend up to October. At cooler sites above altitude of 2800 m, completion of an infection cycle may require more than a year. *Fasciola gigantica* risk was present in the western, southern and north-central regions of the country at altitudes of 1440-2560 m. However, a transmission cycle could be completed in a single year only at elevations below 1700 m. The greatest risk of *F. gigantica* infection was in the humid western region. Regional strategic chemotherapy schemes of two or three treatments per year were developed. Results suggest that the model can be extrapolated to all CPSZ in the country and adapted for use in control of other vector-borne diseases of economic and public health importance.

- [341] Chillot Yirga and Rashid M Hassan. Social costs and incentives for optimal control of soil nutrient depletion in the central highlands of Ethiopia. *Agricultural Systems*, 103(3):153 – 160, 2010.

KEY: YirgHass2010

ANNOTATION: This study analysed trade-offs between short- and long-term objectives of soil use by smallholder teff farmers in Ethiopia. Compared to socially optimal solutions it was found that smallholder farmers discount the future at higher private rates leading to overexploitation of soil nutrients. Current soil conservation efforts, however, are well above static optimization levels suggesting smallholder farmers consider the long-term (dynamic) costs of soil degradation. There is evidence of high social gains from better utilization of soil resources through appropriate policy such as tenure security, to improve incentives for smallholder farmers to adjust input use towards socially desirable dynamic optimization levels.

- [342] Joshua O Yukich, Mehari Zerom, Tewolde Ghebremeskel, Fabrizio Tediosi, and Christian Lengeler. Costs and cost-effectiveness of vector control in Eritrea using insecticide-treated bed nets. *Malaria Journal*, 8:14 pages, accessed 26:October:2010, March 2009.

KEY: YukiEtA12009

ANNOTATION: Background: While insecticide-treated nets (ITNs) are a recognized effective method for preventing malaria, there has been an extensive debate in recent years about the best large-scale implementation strategy. Implementation costs and cost-effectiveness are important elements to consider when planning ITN programmes, but so far little information on these aspects is available from national programmes. Methods: This study uses a standardized methodology, as part of a larger comparative study, to collect cost data and cost-effectiveness estimates from a large programme providing ITNs at the community level and ante-natal care facilities in Eritrea. This is a unique model of ITN implementation fully integrated into the public health system. Results: Base case analysis results indicated that the average annual cost of ITN delivery (2005 USD 3.98) was very attractive when compared with past ITN delivery studies at different scales. Financing was largely from donor sources though the Eritrean government and net users also contributed funding. The intervention's cost-effectiveness was in a highly attractive range for sub-Saharan Africa. The cost per DALY averted was USD 13-44. The cost per death averted was USD 438-1449. Distribution of nets coincided with significant increases in coverage and usage of nets nationwide, approaching or exceeding international targets in some areas. Conclusion: ITNs can be cost-effectively delivered at a large scale in sub-Saharan Africa through a distribution system that is highly integrated into the health system. Operating and sustaining such a system still requires strong donor funding and support as well as a functional and extensive system of health facilities and community health workers already in place.

- [343] Pieter van der Zaag. Asymmetry and equity in water resources management; critical institutional issues for southern Africa. *Water Resources Management*, 21(12):1993–2004, December 2007.

KEY: Zaag2007

ANNOTATION: Water users wish to achieve the highest benefits from water resources. Rules limit the manner in which water users may utilise the water resources occurring within their constituencies or territories. However an asymmetrical situation exists whereby downstream users may not affect upstream users but upstream users do cause downstream impacts. Because of this asymmetry the equitable sharing of water resources between upstream and downstream users will always imply that upstream users have to forego some potential water benefits. The general question that this paper addresses is: which institutional arrangements can be devised to (re-)establish an equilibrium between up- and downstream entities within a catchment area or river basin? The paper addresses this question by first focusing on some local and national water allocation arrangements. After briefly reviewing the different management regimes, customary and colonial, that co-evolved in Southern Africa, it assesses the water management principles that are currently being espoused. The focus then turns to the principles in international water law that deal with the allocation of water in transboundary river basins. It is concluded that it often proves difficult to reach agreement

over how to share the scarce resource. The paper then discusses the current trend to look beyond water and beyond the river basin when seeking peaceful means to share a common water resource. The concept of *hydrosolidarity* emerges as a normative value that may help to recreate a balance between the various (asymmetrical) interests that exist within a river basin. The paper concludes that water resources can only be governed wisely if there is capacity to understand and monitor the water fluxes within a river basin. If such capacity is wanting, priority should be given to strengthen it.

- [344] Gul Zaman, Yong Han Kang, and Il Hyo Jung. Optimal treatment of an SIR epidemic model with time delay. *Biosystems*, 98(1):43–50, October 2009.

KEY: ZamaEtAl2009

ANNOTATION: In this paper the optimal control strategies of an SIR (susceptible-infected-recovered) epidemic model with time delay are introduced. In order to do this, we consider an optimally controlled SIR epidemic model with time delay where a control means treatment for infectious hosts. We use optimal control approach to minimize the probability that the infected individuals spread and to maximize the total number of susceptible and recovered individuals. We first derive the basic reproduction number and investigate the dynamical behavior of the controlled SIR epidemic model. We also show the existence of an optimal control for the control system and present numerical simulations on real data regarding the course of Ebola virus in Congo. Our results indicate that a small contact rate (probability of infection) is suitable for eradication of the disease (Ebola virus) and this is one way of optimal treatment strategies for infectious hosts.

- [345] S Zingore, E Gonzalez-Estrada, R J Delve, M Herrero, J P Dimes, and K E Giller. An integrated evaluation of strategies for enhancing productivity and profitability of resource-constrained smallholder farms in Zimbabwe. *Agricultural Systems*, 101(1-2):57–68, June 2009.

KEY: ZingEtAl2009

ANNOTATION: In African smallholder agriculture, improved farm-scale understanding of the interaction between the household, crops, soils and livestock is required to develop appropriate strategies for improving productivity. A combination of models was used to analyse land use and labour allocation strategies for optimizing income for wealthy (2.5 ha with eight cattle) and poor (0.9 ha Without cattle) farms in Murewa, Zimbabwe. Trade-offs between profitability, labour use and partial nutrient balances were also evaluated for alternative resource management strategies. Farm data were captured using the Integrated Modelling Platform for Mixed Animal-Crop Systems (IM-PACT), which was directly linked to the Household Resource use Optimization Model (HROM). HROM was applied to optimize net cash income within the constraints specific to the households. Effects of alternative nutrient resource management strategies in crop and milk production were simulated using the Agricultural Production Systems Simulator (APSIM) and RUMI-NANT models, respectively, and the output evaluated using HROM. The poor farm had a net income of US\$ 1 yr(-1) and the farmer relied on selling unskilled labour to supplement her income. The poor farm's income was marginally increased by US\$18 yr(-1) and the soil nitrogen (N) balance was increased from 6 to 9 kg ha(-1) yr(-1) by expanding groundnut production from the previous 5-25% of the land area. Further increases in area allocated to groundnut production were constrained by lack of labour. On the poor farm, maize production was most profitable when cultivated on a reduced land area with optimal weeding. The wealthy farm had a maize-dominated cropping system that yielded a net cash balance of US\$290 yr(-1), mainly from the sale of crop produce. Net income could be increased to US\$1 175 yr(-1), by re-allocating the 240 hired labour-days more efficiently, although this reallocation substantially reduced partial soil N and phosphorus (P) balances by 74 kg N ha(-1) and 11 kg P ha(-1), respectively, resulting in negative nutrient balances. Few opportunities existed to increase productivity and income of the smallholder farms without inducing negative nutrient balances. On the wealthy farm, groundnut was the least profitable crop; shifting its production to the most fertile field did not improve income unless the groundnut residues were fed to lactating cows. The analysis carried out in this paper highlights the need to develop practical technological recommendations and development interventions that consider farm resource endowment (land, fertilizers, manure and labour), variability in soil fertility within farms and competing resource use options.

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