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Review

Biofuel potential and FAO's estimates of available land: The case of Tanzania

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While there exists under-utilized lands in several countries of sub-Saharan Africa, the drive towards transforming huge areas of land to biofuel plantations must be reviewed critically. Both the facts that much of these lands are presently covered with forests or classified as wetlands, having a high carbon storage capacity and that these lands are used by local communities for their survival, must be acknowledged. The article analyzes the reasons why public authorities, academics and non-governmental organizations operate with very high estimates on available lands for agriculture in Tanzania, more specifically 550 km^2 or almost two thirds of its territory. A figure which does not take into account the competing uses of the land, such as livestock or harvesting from the forest, or the need to preserve forests and other fragile ecosystems and areas under conservation, must be considered as highly problematic. Both this figure and other, much lower figures, originate from FAO. Even if subsequent FAO reports reiterate that this high figure should be used with caution, the article builds an argument to call upon FAO to explicitly denounce the use of this high figure, as it is not appropriate to apply it as a basis for planning agricultural expansion in Tanzania.

Key words: Biofuels, land availability, food and agricultural organization (FAO), agro-ecological assessment.

INTRODUCTION

An appropriate land use is crucial for sustainable development. Chapter 10 of the World Summit for Environment and Development Programme for Action ('Agenda 21') is on Integrated Approach to the Planning and Management of Land Resources, with the first paragraph reading (extracts):

"Expanding human requirements and economic activities are placing ever increasing pressures on land resources, creating competition and conflicts and resulting in suboptimal use of both land and land resources. If, in the future, human requirements are to be met in a sustainable manner, it is now essential to resolve these conflicts and move towards more effective and efficient use of land and its natural resources. Integrated physical and land-use planning and management are an eminently practical way to achieve this. By examining all uses of land in an integrated manner, it makes it possible to minimize conflicts, to make the most efficient trade-offs and to link social and economic development with environmental protection and enhancement, thus helping to achieve the objectives of sustainable development" (UNEP, 1992 Chapter 10, paragraph 1).

In order to achieve a better understanding of how much land that should be available for human requirements, in particular if there are any finite limits on how much land that could be set aside for producing biofuels, this article will analyze the expectations that have been expressed regarding available land in Tanzania. The article seeks to explain the basis for the figures given by various actors in Tanzania which says that almost 2/3, or 550 km^2 of Tanzania's land is 'arable' (Government of Tanzania, 2008) 'potentially available for agriculture' (WWF Tanzania, 2008) or 'potential area for rain-fed crop production' (Mwamila et al., 2008; Benjaminsen et al., 2008; GTZ, 2005). These figures indicate that there are hardly any limitations as regards land that can be converted into biofuel production. These estimates are widely different from other estimates regarding available land in Tanzania.

First, when the Food and Agricultural Organization (FAO) published statistics in the Production Yearbook (FAO, 2003), the figures for Tanzania were 51 km^2 as 'arable land and permanent crops' and 11 km^2 as 'land under permanent crops', respectively. The same figures appear in the World Bank's World Development Report 2008

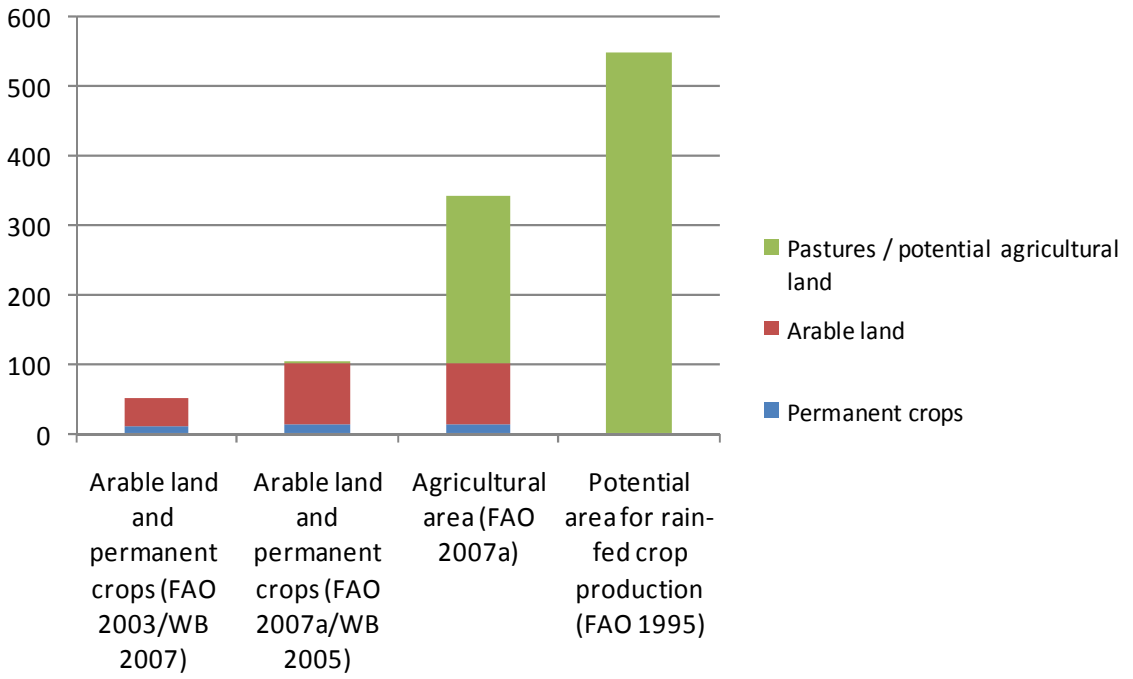

Figure 1. FAO statistics indicating the estimates of available land in Tanzania for human requirements.

(World Bank, 2007). This implies that approximately 5.5% of Tanzania is considered arable, a relatively low estimate. Second, a higher figure says that 102 km^2 of Tanzania can be classified as 'arable land and permanent crops' (FAO, 2007a). This figure is more or less similar to the figures appearing on the World Bank's World Development Indicators Database: 10.4 % of Tanzania's land is said to be arable, while 1.3% is said to be land under permanent crops (World Bank, 2005). A discrepancy of almost 50 km^2 indicates that there is much uncertainty regarding the total arable land.

Third, more recent FAO statistics which include additional categories, such as 'agricultural area' and 'permanent pastures', which were not included in the latter volumes of the production yearbook, but which are included in FAOSAT (FAO, 2007a). 'Agricultural Area' is defined as the sum of 'Arable land and Permanent crops' and 'Permanent pastures' (FAO, undated). Tanzania's agricultural area is estimated to be 342 km^2 (38% of the total land area of Tanzania).

All these figures are, nevertheless, lower than the figures applied by most Tanzanian actors and quoted above. The author has not come across any other country where the figures from the 1995 FAO study are applied in the same frequent manner. If the figure is to become the basis for Tanzanian biofuel policy, it will generate conflicts, not the least because Tanzania is a state in which almost all the land is state owned. Approximately 75% of the state land is, however, administered by the village councils in accordance with the 1999 Village Land Act and the villagers depend on unimpeded access to this land for their continued harvesting. Not all village councils are appropriately aware of the provisions of the Village Land Act and of the borders of the land which their village administers (WWF Tanzania, 2008; Mwamila et al., 2008). Conflicts over land use will arise when village land is earmarked for investment and transferred to the Tanzania Investment Centre in accordance with the 1997 Investment Act. Moreover, converting lands in this way, "could fuel a food crisis in the country", as noted by a Tanzanian Deputy Minister (Guardian, 2009).

Some Tanzanian actors apply even higher figures, saying that 583.000 km^2 is available for development (Tanzania Investment Center, 2008). With the exception of the latter figure, the other figures are presented in Figure 1.

Moreover, it must be added that one study that refers to the 550 km^2 of land that is available for rain-fed crop production (Mwamila et al., 2008) also refers to statistics developed within the National Land Use Frame Work Plan (2007 - 2027), which finds that the total land to be excluded from any form of cultivation activities is 56%, primarily due to conservation, leaving 44% for the different uses (Mwamila et al., 2008). This latter figure is not presented by those actors seeking to promote biofuel investments in Tanzania.

Hence, while previous estimates says that 5 or 10%, respectively is arable, most Tanzanian actors believe that more than 60% of the area can be used for agriculture. This discrepancy and the uncertainty on the figures becomes even greater when we learn that the highest

figure, which is 'land with rain-fed crop production potential' originates from a 1995 FAO study (FAO, 1995). In other words, all these figures originate from FAO.

The article will clarify the reasons why diverse figures appear and challenge them, based on a concern both for the local and global environment and for the local communities affected if a substantively larger share of Tanzania's land is converted into agricultural land in order to grow biofuels. Hence, by building an agreement on how much that is actually available, the policies must be expected to be more appropriate, avoiding competition and conflicts and better integrate social and economic development with environmental protection (UNEP, 1992).

The article will seek to answer why the figures from the 1995 FAO study are used so frequently in Tanzania. First, there will be a clarification of the terminology and analysis of how the application of different terms has implications for the high expectations regarding available lands. Then there will be a critical review of the origin of the very high numbers that appear in different FAO reports. The article will also assess whether the FAO should be morally obliged to denounce the use of the figures if they are presented without any qualifications or conditions to argue for substantially enhanced areas devoted to biofuels. Finally, the different estimates on the global areas to be used for biofuels – which also do differ considerably – will be analyzed.

TERMINOLOGY ON AGRICULTURAL LAND

There are in total six terms which must be clarified to be able to have a proper understanding of land availability. These are: (i) 'Land under permanent crops'; (ii) arable land; (iii) pastures; (iv) agricultural area; (v) 'land under cultivation'; and (vi) 'land with rain-fed crop production potential'. 'Land under permanent crops' is land cultivated with crops that do not have to be replanted each year, including fruit-trees and nut-trees, but not trees grown for the production of timber (FAO, 2003).

Data on 'arable land' is, as stated by FAO, "not meant to indicate the amount of land that is potentially cultivable" (FAO, 2003). Arable land is therefore an indication of the land that might be available for cultivation, but which should not be used as a basis for any agricultural strategy. There might be both traditional uses and conservation interests that will effectively restrict the amount of arable land that should be used for cultivation.

'Pastures' is also referred to as 'temporary meadows and pastures' (FAO, 2007a). According to the FAO's statistical yearbook 2006, Tanzania has 430,000 km^2 available as meadows and pastures (FAO, 2006a), representing almost half of the total land area and more than eight times as much as 'arable land and permanent crops'. FAO clarifies: "The dividing line between this category and the category 'Forests and woodland' is rather indefinite, especially in the case of shrubs, savannah, etc., which may have been reported under either of these two categories" (FAO, undated).

'Agricultural area' is defined as the sum of 'arable land and permanent crops' and 'permanent pastures' (FAO, undated). Based on the acknowledgement of the indefinite dividing line between 'pastures' and 'forests', 'agricultural land' must be understood to be a very wide category, indicating all lands that is neither mountains, nor water or forests. While this term is descriptive, it cannot be understood to be an appropriate basis for any strategy on expansion of the agricultural area, as there is a need for much more comprehensive vulnerability analysis.

'Cultivated land' is the term used by Fischer et al. (2002), finding that 15 million km^2 globally is 'cultivated land'. This Global Agro-ecological Assessment for Agriculture in the 21st Century, of which FAO is a partner, also finds that 96.5% of the world's total land are under 'severe' or 'moderate' environmental constraints for rain-fed crop production (Fischer et al., 2002). To cultivate must be understood to actually modify the land, not only utilize land. The categories applied in the assessment which relate to cultivation are 'Mosaics, including cropland', 'Mosaics, mainly agriculture' and 'dominantly croplands', representing a total of 20% of all land globally. As this is actually 26 million km^2, the three categories cannot be understood to be sufficiently distinctive between actual cultivated land and other grassland. The global estimates of 'cultivated land' are actually eleven times higher than the global estimates of 'land under permanent crops' (FAO, 2003; 1.302.570 mill. km^2; FAO, 2006a; 358.210 million km^2; FAO, 2007a; 1.425.714 km^2). Hence, the term 'cultivated land' cannot be said to be a sufficiently precise term, neither in conceptual nor in operational terms.

Finally, the term 'land with total rain fed production potential' was introduced in a 1995 FAO study. As noted above (FAO, 1995), the figures applied in this report say that 550 km^2 are potentially available in Tanzania. The global estimates of the same report say that 18 million km^2 have a 'rain fed production potential'. This number is presented in the 1995 study with substantial qualifications (FAO, 1995). Recently, a FAO report referred to a figure on land availability of 20 million km^2, saying that this figure "…should be treated with considerable caution…" (FAO, 2008). These qualifications are never instructed to when the Tanzanian authorities mention the figures. Hence, a figure which FAO itself continues to present with several qualifications, is widely reproduced – without any qualifications.

The six terms or categories are applied in different contexts. The most frequent application of the categories is those that appear in FAOSTAT (FAO, 2007), namely permanent crops, arable land and pastures. Cultivated land and 'land with total rain fed production potential' are less frequently applied categories, but not in the case of Tanzania, where the latter category is most frequently

applied.

REASONS FOR THE FREQUENT MENTIONING OF THE HIGH ESTIMATE

The explanations for why it is difficult to identify better figures can be grouped under three main headings. First, the methodology for collecting data on various soil coverage on a global scale. Second, the inaccurate categorization and registration by national governments. Third, the overall policy objectives of FAO, emphasizing enhanced agricultural production over forest conservation, imply a positive assessment of available lands for agricultural production.

The first concern relates to how the global data are collected. Both the 1995 FAO study and the 2002 Global Agro-ecological Assessment are based on geographical mapping. These mappings are based on conditions relating to soil, climate and terrain, to find length of growing periods (LGP), operationalized as the number of days when moisture availability in the soil permits crop growth (FAO, 1995). The whole land surface is divided into agroecological cells, being "pieces of land of varying size with homogenous soil, land form and climate attributes" (FAO, 1995). This then provides for determining global agro-ecological zones (GAEZ), based on different land utilization types (LUT) (Fischer et al., 2002). The limited adequacy of land use system information has been identified (de Bie, 2000). Several initiatives on land use classification took place in the 1990s (FAO, 1999), but recently the emphasis seems to be more on the land evaluation (FAO, 2007b).

The current global ecological assessments are not adequately precise to be applied as a basis for agricultural or environmental strategies locally. More detailed information on the actual use, or the possibilities for use, for instance when land is set aside for nature protection purposes, must obviously be included when macro data are presented. As an example, Tanzania has 39.6% of its total area as 'protected areas', most of it falling under IUCN category (VI) 'Managed Resource Protected Area'.

Moreover, these estimates do not take into account land degradation (Fischer et al., 2002), which is taking place as a result of several processes, including human induced climate change, erosion and salination.

As was seen above, both the area of 'cultivated land' and 'land with total rain fed production potential' include forests. Hence, FAO (1995) admits that of the land with total rain fed potential "at least 45%, but probably much more…" is under forests. Moreover, the Global Agro-ecological Assessment for Agriculture find that 2.98 million km^2 of land considered to be suitable or very suitable for wheat, rice, or maize coincide with land classified as predominantly forest ecosystems (Fischer et al., 2001). The authors state, however, with regard to Latin America and Africa: "In these two regions there is clearly scope for further expansion of agricultural land, even assuming that current forests are maintained" (Fischer et al., 2001).

FAO has recently acknowledged that land-use change, implying that forest lands are converted to agricultural lands, is the source with the most significant effect on greenhouse gas emission (FAO, 2008). This is not, however, in line with most other assessments, which find that 'power' represents 24% of global emissions of greenhouse gasses while 'land use change' represents 18% (World Bank, 2008). Notwithstanding this minor disagreement, any estimates saying that 3 million km^2 of forest land is suitable or very suitable for agriculture must be treated with utmost caution and should rather be rejected as inappropriate.

Second, there seems to be a lack of specific instructions regarding categorization and registration of different types of land, except from the definitions that are provided by FAO itself. The last volumes of the production yearbook gave a reduced number of land categories. This is explained by FAO by the following factors: "non reporting of data for certain land categories; incomplete coverage […]; difficulties in standardization of land-use concepts and definitions…." (FAO, 2003). While these problems recognized by FAO cannot be presumed to have been eliminated, both FAO statistics yearbook (FAO, 2006a) and FAOSTAT (FAO, 2007a) do include more land-use categories than the last volumes of the production yearbook. Both the FAO statistical yearbook and FAOSTAT hence rely upon the numbers given by the respective governments. This does not provide a full guarantee that the numbers are correct, but there is at least a possibility that a government can be held accountable for willfully presenting wrong information.

Third, it will be analyzed to which extent FAO is primarily concerned with enhanced production of food, even if also has a mandate relating to forest resources and whether this emphasis on food production imply that less attention is devoted to forest conservation, both when developing statistics and when advising on policies. The emphasis of FAO on enhanced food production is not illogical, both as the number of hungry or 'undernourished' persons has now passed 1 billion persons (FAO, 2009a) and as the FAO Constitution Article 1.2 as revised in 1965 ('Functions of the Organization') is referring to improved agricultural production in three out of six paragraphs specifying what FAO is to promote namely (FAO, 1998). Only one of the functions relate to 'conservation of natural resources' and this formulation, found in paragraph 1.2(c), is followed by the formulation 'and the adoption of improved methods of agricultural production'. This implies that even conservation is done with the purpose of having a resource base for the enhanced agricultural production.

Therefore, the value of forest conservation cannot be said to be a priority of the FAO, based on how the Constitution of the FAO is worded, but there is no basis for saying that forest conservation is given too little emphasis in the operational work of the FAO (FAO, 2009b; FAO, in the operational work of the FAO (FAO, 2009b; FAO, 2009c; FAO, 2006b; FAO, 2005).

Among these three explanations for why the numbers on various categories of land differ substantively between different data sets, it seems that the most important explanation is the methodology for collecting data on a global level and the lack of standardization of land-use concepts and definitions when generating statistics on a country level. There is no basis for saying that the FAO has FAO is likely to present only the highest available figures on available agricultural areas.

Notwithstanding the different approaches on how agricultural areas shall be estimated, it seems reasonable to state that the numbers given in both the FAO 1995 study and in the 2002 Global Agro-ecological Assessment for Agriculture are too high and that also the term 'agricultural area' should not be presented without any qualifications. Even the much less amount of 'arable land', as specified by FAO, "should not be considered as a reserve readily available for agricultural expansion" (FAO, 1995).

There is no doubt that the use of terms in FAO statistics – which are being understood differently by different actors – is one of the factors contributing to an understanding that there are vast areas available for agricultural production. Moreover, while the statistics is presented with several qualifying conditions, these conditions are ignored when the very high estimates of land available for cultivation are used directly as arguments in assessing the potential for agricultural production, including biofuel production.

RATIONALE BEHIND DENOUNCING THE HIGHER FIGURES FROM FAO

To illustrate the problems with applying the high figure as applying to Tanzania, an argument will be developed based on the inaccuracy of the global figures developed by the Global Agro-ecological Assessment for Agriculture ('the Assessment'). The Assessment found that almost 4/5 of the total land is under 'severe environmental constraints' (termed 'moderately suitable'), that 1/5 of the total land is under moderate constraints (termed 'suitable') and that only 3.5% of total land area are without constraints (termed 'very suitable') Fischer et al., 2002). Two issues arise from this: the use of the terms, and the presentation of the figures.

First, it is inaccurate to rephrase the term 'severe constraints' to say that the soil is 'moderately suitable' for agriculture. The term 'severe' implies that this land should not be used for agricultural cultivation, but that planting trees is much more appropriate in order to improve the quality of arid lands.

In the context of biofuels, it must be acknowledged that biofuel production cannot be analyzed as one overall activity. As an example, there is a huge difference between the destruction of forests to give way for biofuels plantations and a biofuel plantation consisting of *Jatropha curcas* trees in arid lands. While neither of these lands are in themselves appropriate for cultivation, as *J. curcas* trees in arid lands yields considerably less than in normal lands (Chen et al., 2008; Kamanga, 2008), the latter can make a positive contribution in combating erosion and give nutrition to the soil, while the former will have negative effects on erosion, nutrition, biodiversity, water storage capacity and a policy bias against forest conservation which implies thatcarbon storage capacity, but only if sown as seeds and not propagated as cuttings (FAO, 2003).

Second, another argument that can be taken from the assessment is that the land area which is considered 'very suitable' for agriculture is less than 5 million km^2. This area is more than three times the current global area of 'land under permanent crops' (FAO, 2007a), but is less than a third of the global area of 'arable land and permanent crops' (FAO, 2007a). As 'arable land' is not meant to indicate the amount of land that is potentially cultivable (FAO, 2003), there is reason to warn against any strategy seeking to expand considerably the global agricultural area. The figures are even more absurd if one adds the so-called 'suitable land' and 'very suitable land' of the assessment, summing up to 25 million km^2. Hence, it must be considered obvious that general categorizations and classifications cannot be used as a basis for any strategy for expanding the area used for agriculture.

The Millennium Ecosystem Assessment found that among the 14 terrestrial biomes ('the largest unit of ecological classification'), there had been a conversion of more than half of their original areas by 1990 for six of these, primarily to agriculture (Millennium Ecosystem Assessment, 2005). For 'tropical and sub-tropical coniferous forests' the conversion by 1990 was approximately 40%, but by 2050 this is expected to be close to 70% (Millennium Ecosystem Assessment, 2005). Moreover, while global food production will increase until 2050, this will go parallel with degradation of other ecosystem services (Millennium Ecosystem Assessment, 2005).

Hence, as a partner to the assessment, FAO should distance itself from a too categorical use of the figures produced through the assessment. The same applies to the figures in the 1995 FAO study, which are more easily referred to by national authorities simply as they are given on the country level. Rather than expanding considerably the land under cultivation, there must be a more effective and efficient use of land and its natural resources (UNEP, 1992).

Moreover, FAO should be made cognizant of the fact that the two terms 'arable land' and 'agricultural area' are semantically very similar, even if the respective areas they refer to are substantially different from each other. If the term 'agricultural area' shall continue to be applied, it should have an explanatory text saying that this is not area that is readily available for agricultural use, but rather relates to certain land cover classes, such as grassland and cropland (Fischer et al., 2002). As there is a certain likelihood that the term will continue to be misunderstood and misrepresented, FAO should consider whether it is a

solution to return to the presentation chosen in the latest volumes of the production yearbook, from 1996 onwards, where only three categories were applied: 'arable land', 'land under permanent crops' and 'non-arable land and non-permanent crops' (FAO, 2003).

This change in terminology and presentation could imply a change in certain national policies. Such policy changes, uses and harvesting from the land, on the one hand and a utilization of the land for biofuel production, on the other hand. A Tanzanian study has found that the value of harvesting of non-timber forest products (NTFP) from the land and forest is approximately similar as the value of using the same land for agriculture and in those districts with a high dependency upon wood as a source of energy, the value of harvesting NTFP is higher than the value of agriculture on the same land (Mwamila et al., 2008). Moreover, a FAO report on land evaluation finds that there are two main factors calling for revision of the land evaluation framework: First, the recognition of the wider functions and services of land. Second, the growing recognition given to stakeholders, in particular villages, rural communities and individual farmers and other land users (FAO, 2007b).

PROJECTIONS ON LAND USED FOR BIOFUELS

The article should not be read as a general rejection of biofuels. The article has, however, hopefully given evidence that macro-assessments are not appropriate for specific policies. There must be a much deeper understanding of the constraints and possibilities when areas are set aside for the production of those biofuels which require land for their production. Hence, the concerns raised are as relevant for many of the second generation biofuels, like wood diesel and for all first generation biofuels, including the non-edible plant jatropha. To give further evidence of the ecological constraints, Tanzania is ranked as 64th in FAO's ranking of countries regarding 'land resource potential and constraints' (FAO, 2000). The country ranking is based on seven variables: (i) potential arable land as a percentage of total land area; (ii) deserts and dry lands; (iii) steeplands; (iv) land degradation severity; (v) land presently cultivated (actual arable land) per capita; (vi) cultivated land as a percentage of potential arable land; and (vii) population increase (per cent per year). This ranking does at least indicate that large areas of Tanzania cannot readily be used for agriculture without affecting the ecological balance of many regions of Tanzania.

There are several calculations on lands likely to be made available for biofuel production. In this context it is relevant to remind ourselves of the fact that currently only 2% of biomass globally is used for transport. Liquid biofuels do only represent 1.9% of total bioenergy (FAO 2008).

According to the International Energy Agency (IEA), a six-fold increase of world biofuel production and consumption is projected to take place between 2004 and 2030 (IEA, 2006). Other estimates, measuring energy equivalents says that total biomass energy use will increase from the current numbers of 46 EJ (10^18 Joules – of which 9 EJ is modern bioenergy use, including biofuels) in turn, could reduce the risk of conflicts between traditional biofuels) to a range between 50 and 250 EJ by 2050 (Dornburg et al., 2008; Smeets et al., 2007; Smeets and Faaij, 2007). This wide discrepancy indicates that any exact assessment is difficult to make. If one, however, applies the IEA's projections, a six-fold increase in biofuel production and consumption is not directly reflected in the projections for the total area set aside for biofuel production. The IEA projection for biofuels use by 2030 is that there will be an increase in the area used for biofuels from the current area of 150 to 350 or 500 km^2 (IEA, 2006).

An explanation for this discrepancy between the formidable increases in biofuel production and the more modest increase in land set aside for biofuel production is that a large amount of the increase in biofuel production will come from algae and waste and other second generation biofuels and not forests or first generation biofuels.

IEA has also made projections on continents within this global projection, ranging between 350 and 500 km^2 for biofuel production. The area that is projected to be used for biofuels in Africa and Near East is very small, estimated to be less than 10 km^2 under both projections. Asia is projected to have up to 100 km^2 used for biofuels and Latin America is projected to have 40 km^2 used for biofuels under the highest projection (IEA, 2006). The large areas are projected to be in USA and Europe.

This indicates at least that it is not likely that the total area used for biofuels in Tanzania or other African states will come close to the very high numbers of available land that have been presented as potentially available.

These relatively low estimates on the amounts of land that will be set aside for biofuel production cannot, however, be interpreted to indicate that there will be no conflicts over land. While acknowledging the national strategies for reduced dependency on imported oil, the states need to have in place appropriate legislation and institutions for an adequate administration of land.

If any expansion of agricultural areas for biofuel production is not to come on the expense of local land ownership, traditional harvesting possibilities and the local and global environment, there must be in place coherent law-based policies for the use of land. Moreover, the biofuel policies must be based on cautious assessments of how much land that is actually available – if the production of biofuels is not to be in direct conflict with a broad range of human rights and environmental obligations. Hence, several figures on land availability appearing in the 1995 FAO study, in FAOSTAT and in the 2005-2006 Statistical Yearbook should not be seen as a sufficient basis for

national strategies for extending the agricultural areas.

CONCLUSION

The article has shown that not only Tanzanian authorities, but also NGOs and academics apply the total area estimated as 'potential for rain-fed crop production' as equivalent with the area that can be set aside for agricultural production. The author is not aware of any other country where this number is applied in a similarly consistent manner as a part of a political rhetoric claiming that enormous areas are available, even if the annual numbers given in the FAO Statistical Yearbook or on the FAOSTAT homepage are considerably lower.

Moreover, the article finds that even if the different land-use categories are defined by FAO, an ordinary person would not readily be able to make any proper distinction between the different categories used. As one example, the difference between agricultural land, on the one hand and arable land, on the other hand, does not seem great in semantic terms, but is considerable in reality, as the former includes also pastures (and meadows). The term 'agricultural land' too easily gives connotations to lands that are either in use or ready to be used for cultivation-based agriculture, even if such use cannot be presumed to be appropriate in many circumstances.

On the term 'arable land', which could refer to areas several times smaller than the corresponding 'agricultural land' FAO explicitly says that available figures are not meant to indicate the amount of land that is potentially cultivable (FAO, 2003). This is an important call for caution. The figures produced in the 1995 Study (FAO, 1995) and the 2002 Global Agro-ecological Assessment for Agriculture (Fischer et al., 2002) simply cannot be considered to be sufficiently accurate or ecologically justifiable to be applied as a basis for national strategies on land policies, either in agriculture or forestry. The present knowledge of the carbon stock in forests that will best be upheld by keeping the forests intact should be an adequate basis for this conclusion.

Finally, the article has also shown that there is a relatively wide discrepancy between which areas that are said to be available in a country like Tanzania for the production of biofuels and the estimates by the IEA on the total area planted by biofuels by 2030 in Africa.

REFERENCES

Benjaminsen TA, I Bryceson, F Maganga (2008). Climate Change in Tanzania: Trends, Policies and Initiatives, Norwegian University of Life Sciences, Ås.

Chen B, Landsman-Roos N, Naughton R, Olenyik K (2008). Jatropha curcas L.: Biodiesel Solution or All Hype? A Scientific, Economic and Political Analysis of the Future Energy Crop. Available at: http://humanities.uchicago.edu/orgs/institute/bigproblems/bp-energy.html.

de Bie CAJM (2000). Comparative Performance Analysis of Agro-Ecosystems. Unpublished PhD dissertation, available at: http://www.itc.nl/personal/debie/PhD_Thesis.pdf.

Dornburg VA, Faaij P, Verweij H, Langeveld G, ven de Ven F, Wester H, van KK, ven DM, Meeusen M, Banse J, Ros D, ven VGJ, van den BF, Smout J, van Vliet MLH, Mozaffiarian K, Smekens (2008). Biomass Assessment: Assessment of global biomass potentials and their links to food, water, biodiversity, energy demand and economy – Main Report. University of Utrech, Wageningen University, Netherlands

Environmental Assessment Agency, Vrije Universitet Amsterdam, Energy Research Center of the Netherlands and Utrecht Center for Energy Research.

Fischer GH, van VM, Shah FN (2002). Global Agro-ecological Assessment for Agriculture in the 21st Century: Methodology and Results. International Institute for Applied Systems Analysis, Laxenburg, Austria and FAO, Rome.

Fischer GH, van VM, Shah FN (2001). Global Agro-ecological Assessment for Agriculture in the 21st Century [Executive summary of the 2002 report].

Food and Agricultural Organization (FAO) (2009a). 1.02 Billion People Hungry. Available at: http://www.wfp.org/news/news-release/102-billion-people-hungry.

FAO (2009b). Global forest Resource Assessment (FRA) 2010 News. Available at: http://www.fao.org/forestry/52398/en/.

FAO (2009c). State of the World's Forests Report *2009*. FAO Rome.

FAO (2008). The State of Food and Agriculture *2008*. FAO, Rome.

FAO (2007a). Land Use Database. Available at: http://faostat.fao.org/site/377/default.aspx#ancor.

FAO (2007b). Land evaluation: Towards a revised framework, Land and Water Discussion Paper 6. FAO, Rome.

FAO (2006a). Statistics Yearbook 2005-2006 Vol. 2. FAO, Rome.

FAO (2006b). Responsible Management of Planted Forests: Voluntary Guidelines, Planted Forests and Trees Working Paper FP37E. FAO, Rome.

FAO (2005). Global Forest Resources Assessment 2005, FAO Forestry Paper 147. FAO, Rome.

FAO (2003). Production Yearbook Vol. 57. FAO, Rome.

FAO (2000). Land Resource Potential and Constraints at Regional and Country Levels, World Soil Resources Report 90. FAO, Rome.

FAO (1999). Land Use Classification for Agri-environmental Statistics/Indicators. Available at: http://www.unece.org/stats/documents/1999/10/env/13.e.pdf.

FAO (1998). Basic Texts of the Food and Agriculture Organization of the United Nations, Volume I. Rome, FAO.

FAO (1995). World Agriculture: Towards 2010. An FAO Study. Rome, FAO.

FAO (undated). FAO Production Yearbook. Available at: http://www.fao.org/waicent/faostat/agricult/landuse-e.htm.

Government of Tanzania (2008). Biofuels Development in Tanzania. By Hon. William M.

Ngeleja Minister for Energy and Minerals; Presented by H.E. Ngemera A.R. URT Ambassador to Germany, 3rd German-African Energy Forum 23 to 25 April 2008. Available at: www.afrikaverein.de/media/52ca9c726e9c742.

GTZ (Gesellschaft für Technische Zusammenarbeit) (2005). Liquid Biofuels for Transportation in Tanzania: Potential and Implications for Sustainable Agriculture and Energy in the 21st Century. GTZ, Eschborn.

Guardian TZ (2009). 'Govt identifies factors fueling land conflicts'. available at http://www.ippmedia.com/frontend/functions/print_article.php?l=2727.

International Energy Agency (2006). World Energy Outlook 2006. Paris, IEA.

Kamanga K (2008). The Agrofuel Industry in Tanzania: A Critical Enquiry into Challenges and Opportunities. Available at: www.coet.udsm.ac.tz/.../July08%20-%20(Oxfam)%20BIOFUELS.doc.

Millennium Ecosystem Assessment (2005): *Ecosystems and Human* Well-being: Synthesis. Washington D.C, Island Press.

Mwamila BK, Kulindwa O, Kibazohi H, Majamba H, Mlinga D, Charlz M, Chijoriga A, Temu G, John RPC, Temu S, Maliondo S, Nchimbi-Msola Z, Mvena M, Lupala J (2008). Feasibility of Large-Scale Bio-Fuel

Production in Tanzania. UDSM, SUA, Ardhi University, Morogoro and Dar es Salaam.
Smeets EMV, Faaij APC, Lewandowski IM, Turkenburg WC (2007). 'Bottom-up Assessment and Review of Global Bioenergy Potentials to 2050'. Progress in Energy and Combustion Science 33(1): 56-106.
Smeets EMV, Faaij APC (2007). 'Bioenergy Potentials from Forestry in 2050: An assessment of the drivers that determine the potentials'. Clim. change 81(3-4): 353-390.
Tanzania Investment Center (2008).Tanzania Investors Guide. TIC, Dar es Salaam.
UNEP (United Nations Environment Programme) (1992). Agenda 21.
World Bank (2008).Global Monitoring Report 2008. World Bank, Washington D.C.
World Bank (2007). World Development Report 2008: Agriculture for Development. World Bank, Washington D.C.
World Bank (2005). Key Development Data and Statistics. Available at: www.worldbank.org/data/countrydata/countrydata.html. (data appears via 'By Topic'; 'Agriculture').
World Resources Institute (2003). Biodiversity and Protected Areas – Tanzania. Available at: http://earthtrends.wri.org/pdf_library/country_profiles/bio_cou_834.pdf.
WWF Tanzania (2008). Scoping Exercise (Situation Analysis) on the Biofuels Industry Within and Outside Tanzania (written by ESD (Energy for Sustainable Development). WWF, Dar es Salaam, Tz.