academicJournals

Vol. 8(10), pp. 155-162, October 2016
DOI: 10.5897/JENE2016.0578
Article Number: AAED19F60776
ISSN 2006-9847

http://www.academicjournals.org/JENE

Journal of Ecology and The Natural Environment

Review

Population-based theories as an approach to natural resources management in developing countries: A narrative review of Machakos District in Kenya

Ishmael Bobby Mphangwe Kosamu[1]*, Wouter T. de Groot [2], Ansley Kasambara[1], Chikumbusko Chiziwa Kaonga[1], Patrick S. Kambewa[3] and Joseph Nagoli[4]

[1]University of Malawi - The Polytechnic, Private Bag 303, Chichiri, Blantyre 3, Malawi.
[2]Institute of Environmental Sciences (CML), Leiden University, P.O. box 9518,2300 RA Leiden, Netherland.
[3]University of Malawi, P.O. Box 280 Chancellor College, Zomba, Malawi
[4]World Fish Centre, P.O Box 299, Zomba, Malawi.

Received 10 May, 2016; Accepted 25 August, 2016

Many human societies across the world have collapsed or almost gone into extinction because of the scarcity of natural resources. Others however, have survived by either migrating to seek for natural resources elsewhere or by transition and/or adaptation to new environmental conditions. This narrative review paper examines how a society of Machakos District in Kenya has managed to escape from a potential collapse driven by natural resources' scarcity. The review found that most societies in developing countries have failed to: (i) successfully repack natural resources management information into stories that motivate collective action, and (ii) invest in institutional improvement, innovation and technological changes through the influence of political leaders and economic elites. This paper recommends that for developing countries to successfully avoid societal collapse due the scarcity of natural resources, there is need to follow similar pathways like the society of the Machakos District in Kenya.

Key words: Natural resources management, developing countries, societal collapse, population growth, Malthus, Geertz, Boserup.

INTRODUCTION

By the year 2050, the earth will have nine billion inhabitants who are more likely to live on a depleted natural resource base whose scarcity is currently being aggravated by deteriorating environmental and climatic conditions (United Nations, 2015). These unprecedented environmental and climatic conditions make it very difficult for the scientific community to precisely assess if and how the global climate change scenarios will develop into a regular two degrees up or run into an Eocene-like scenario (Lovelock, 2006). On the contrary, what scientists are quite clear about is that natural resources will continually face harvesting pressure which is driven

*Corresponding author. E-mail: ikosamu@poly.ac.mw.

by population growth, rural poverty, land degradation, climate change and use of unsustainable sources of energy, especially in developing countries as has been acknowledged by several scholars (Wunder et al., 2008; Zulu, 2010; Lele, 1991; Place and Otsuka, 2001; FAO, 2010a, b; Nankhuni and Findei, 2004; Sunderlin et al., 2005).

Malthus' (1798) population based theory has already acknowledged that human population tends to grow faster than the capacity of earth to produce the food that humans require. The increasing population growth would unpredictably lead to the collapse of the world; known as the "Mathusian catastrophe", especially in absence of adaptation. In most developing countries in Africa, a similar idea has been supported by the Neo-Mathusian population based theory in the sense that there has been increasing crises which have been hugely manifested by: high rates of population growth, repeated famines, wars, food crises, environmental degradation, soil erosion, crop failure and disastrous floods. Such crises may probably lead to an unprecedented human catastrophe if left unchecked.

On the contrary, Boserup's (1965) population based theory has opposing viewpoints towards both theories of Mathusian and Neo-Mathusian. Boserup strongly believed that people have the resources, knowledge and technology to increase food supplies in case of unprecedented crises such as increasing population pressure, famine, wars, etc. As a result, she suggested, the collapse of human populations might be unlikely. Although, she highlighted that the changes in technology would allow for improved crop strains and increased yields, she admitted that overpopulation can lead to unsuitable farming practices which may contribute to land degradation.

The key point in this review paper is not about the collapse of societies but rather on how societies have managed to survive in the light of dwindling natural resources as emphasised by Butzer and Endfield (2012). As a result, the general theories of development pathways (rural economics) and adaption theories of 'Boserupian', 'Geertzian', 'neo-Boserupian' and Brox (1990) will all be used as ideal models to support the case study of the Machakos District in Kenya. The significance of this review paper is therefore to highlight that as long as humans have knowledge and technology, population-based collapse is unlikely.

This narrative review is structured as follows: i) a discussion of some key concepts on societal change, ii) anoverview of population-based theories on natural resource scarcity including Malthus'(1798),Neo-Mathus,Boserupe and Geertz on population theory and development pathways, iii)a description of the case of Machakos District in Kenya as a model for escaping societal coiiapse particularly in developing countries and ,iv) suggestions on approaches or pathways to escape societal collapse due to natural resource scarcity.

Existing secondary data were extracted from relevant documents such as books, existing reports, publications, journals and internet articles. The relevant documents were accessed, perused and the relevant information/text was compiled, sorted and analyzed based on the objectives of the paper.

CONCEPTS OF SOCIETAL CHANGE

Assessing societal change implies focusing on a system and a set of characteristics driving human interactions with their surrounding environment. Increasing human pressure on the surrounding environment could lead to the extinction of a society. This means that extinction of societies should not be perceived as something intrinsically bad. Theoretically, a society may go extinct as a result of the incapacity to gather sufficient financial benefits to fight against vulnerability factors. As Malthus (1798) already observed, the rich and powerful members of societies will often successfully shift resource availability at the expense of the poor and vulnerable people. This is because the rich and powerful members of the society are the most decisive group and they are able to set up remedial actions to overcome a given issue of resource scarcity. In addition, they represent the primary actors who 'act', 'move', respond' or even 'choose' which remedial actions to put in place. However, the implementation of such collective remedial actions in response to a given stress or shock as compared to a single individual is multi-facetted and time-consuming (Diamond, 2005). This emphasises the fact that societies are often heavily locked into institutional pathways (governance rules, tax systems, organisations, etc.) that require a lot of time and effort to make them work.

The descriptions of evolving societies and their relationships with their natural resources can be either spatially and or temporally related. The spatial dynamic of such actions has to be linked to the role of external markets, the growth of urban centres, and the migration of population and so on. The 'population-based' theories of natural resource scarcity focuses particularly on land degradation following the neo-Thünian ('land rent') story of societal changes (De Groot, 2003) (Figure 1). The figure depicts the situation of a society with growing urban centres and markets (central in the picture), around which expanding and intensive zones of extractive land use are found. The picture symbolizes the US in the 1800s, or 'developing societies' in the present age. Virtually all countries in the world have gone through these stages or are still in it in some points. The full story is based on ideal-type ecological and geographical environments which may help in the explanation of the transition from extensive to intensive farming systems. If the process continues from intensive farming systems to the agriculture frontier and then the extraction frontier, all the frontiers will more likely collapse. As a result, there is

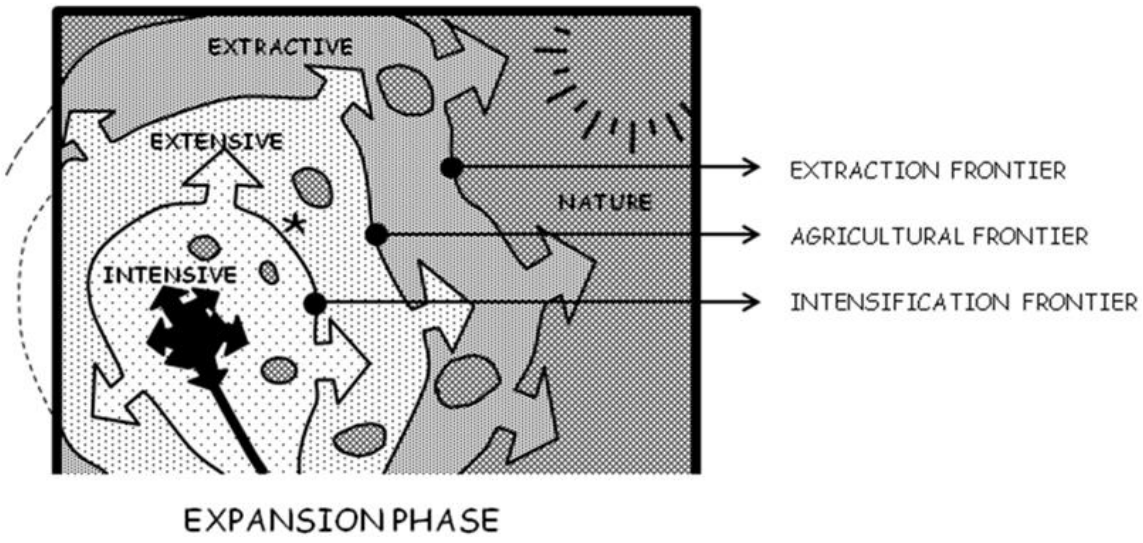

Figure 1. A neo-Thünian symbolization of an expansion phase with land use frontiers moving outward from the expanding urban markets while the round areas depict left-over natural areas (a wetland, water reservoir, etc.) (Adapted from De Groot, 2003).

no more space for further expansion and everything has become internal and the system is finally closed up.

The population-based theories of Malthus on natural resource scarcity fall within the end expansion of figure 1 since it takes into account increasing population growth against land production as the main driver of land collapse. On the contrary, Wilkinson (1973) has stressed that avoiding population collapse and the massive starvation were possible in primitive' societies, despite the fact that population levels had began to approach carrying capacities. Among the reasons evoked is the fact that the Malthus' theory has neglected many external and non-population factors that may be important in natural resources management (Burger and Zaal, 2009), particularly technological and institutional development, as well as cultural and social adaptation.

An overview of population-based theories

Although several population-based theories are available, the first population-based theory was elaborated by Malthus (1798) in his influential essay in which he highlighted that exponential population growth is inherent in all societies, and massive starvation is the general mechanism that keeps populations in check. The focus of his works was on the depletion of natural resources which may lead to the decrease of productivity of human labour. The latter tended to fall below-subsistence wages for the poor and causing their death. Although, he admitted that the reduction of the populations (through birth control) may give rise to cycles of partial recovery, this population reduction may only represent a moral way to escape from the cascade of misery. As an extension of Malthus theory, Homer-Dixon (1999) integrated the political and institutional visions as a way of explaining the collapse of the society by elite groups' capture of natural resources. Indeed, increasing capture of natural resources by elite groups is more likely to drive the collapse of the society since less natural resources is available to meet the livelihood needs of poorer members of the society. However, Geertz (1963) based on studies on rice agriculture in Indonesia, coined the term 'agricultural involution' which is a concept that completely opposes both the Malthus theory and Homer-Dixon (1999) theories as highlighted below.

In the historical process of 'agricultural involution' due to population growth, agriculture becomes ever more labour-intensive, e.g. going from rain-fed to irrigated rice, from broadcast to transplanted rice, ending in systems that are highly productive per hectare but with very low returns to labour. The system remains ecologically sustainable, however, without collapse. If society would control population levels, it could continue forever, with the masses stuck on a very low survival level, supporting a small group of the elite. Gellner's (2006) 'agricultural society' follows an analogous development pathway. The work of Boserup (1965) stands in the same tradition of societal pathways under circumstances of rising population pressure. Her studies end in a somewhat more optimistic conclusion, however. In the Geertzian involution image, there is no real technological progress; people basically continue what they have been doing, only with more and more labour input per hectare. The Boserupian image is one of adaptation rather that involution; mainly driven by ecological necessity.

The modest optimism of Boserup made her the symbol of opposition against the Malthusian 'prophesies'. The

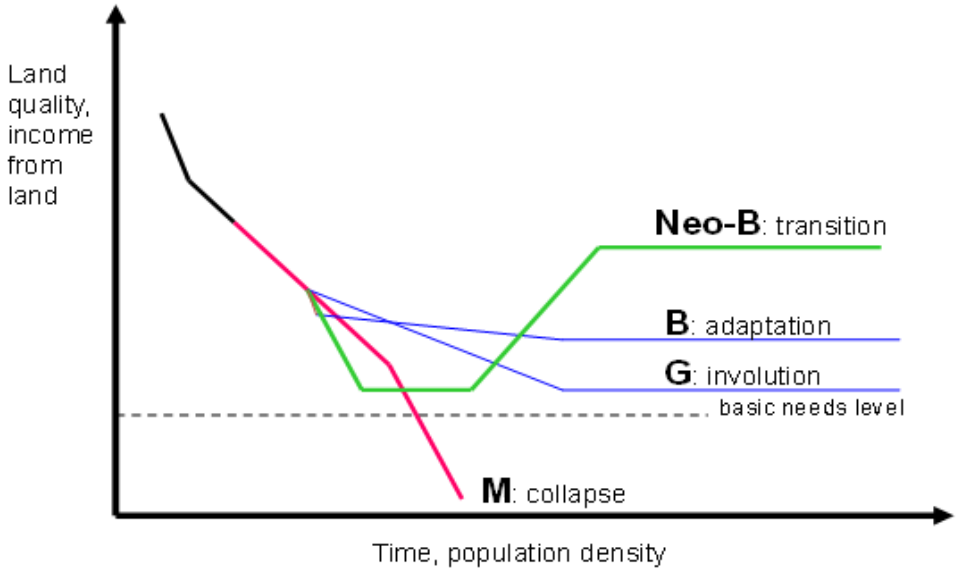

Figure 2. Four ideal-type development pathways in an agricultural society (like Malawi) under rising population pressure. M = Malthusian; G = Geertzian; B = Boserupian; neo-B = neo-Boserupian.

true optimists came later, however. We may call them the 'neo-Boserupians', because they remain within the same family of looking at population-driven change in a relatively closed society. A characteristic product here is Tiffen et al. (1994) book "More People, Less Erosion", a title that boldly positions itself against the Malthusian outlook. The book creates a basis for our insights in the present paper and tells the story of Machakos District in Kenya, that was regarded as a moonscape in the making in the 1930s but 50 years later carried a tripled population with tripled incomes per capita.

The key of this 'miracle of Machakos' was the terrace, thousands of kilometres of which had been constructed, largely by female hands, to cover the whole of the rolling landscape. We will come back to Machakos in the next section. Here it suffices to mark the great difference with the original Boserupian theory not only in terms of outcomes but also in underlying mechanism. The terrace was the cornerstone of a fully innovated farming system, with new crops, new irrigation, new cattle and manure management, new agroforestry and so on. This is transition rather than Boserup's adaptation.

Figure 2 gives an overview of the four population-based theories. The horizontal axis is a combined one ('time, population density'), expressing an assumption of a steady population growth over time. This implies that we are looking at a finite time period; populations cannot grow forever. The vertical axis is also a combined one ('land quality, income from land') implying that we look at basically agricultural regions where soils, forests, water and other natural resources determine the amount of effort needed by 'developing societies' for a decent harvest and improved livelihoods.

Stressing further on Figure 2, the four development pathway's curves start from the 'original affluence', especially from the Malthusian and neo-Boserupian collapse transition. At this point in time, incomes tend to be low because of the low investments provided to set this pathway in motion. As a result, irrigation systems need to be constructed, trees planted, new animal husbandry systems tried out. Among the actions needed at institution level, there is a need to implement negotiated new rules, redefined gender roles along with organised collective actions. These trends are quite crucial to explain the Mathusian assumption on 'poverty trap'. In that regards, individual actors or the whole societies may find themselves locked in. On way down from the original affluence, actors are initially wealthy enough to invest in innovation, but the motivation to do so tends to be low, since things are still going well enough. By the time the incomes have declined to the basic needs level, the situation is reversed; the motivation for change is high but the capacity to act has become zero (Hobbes et al., 2011).

From Figure 2, it can be implied that societies can follow one path after another, e.g. displaying a long Geertzian decline after a rapid neo-Boserupian upswing. For instance, agriculture in Bangladesh (Turner and Ali, 1996) shows a Geertzian long-term trend but interrupted by Boserupian 'ups' e.g. due to the green revolution. It also implies that different groups within a society may follow different pathways under the overall pathway of the society as a whole. One well-known issue is that in strongly neo-liberal societies that lack effective equity

mechanisms, the tendency of markets to work to the net advantage of the rich (e.g. due to their greater negotiation power) may result in increasing poverty of the poor (M or G) in spite of overall economic growth (B or neo-B). A final point to note here is that these development pathway ideal-types are scale and time independent.

In the section below, the story of 'Machakos society' will be used as key case studies to successfully illustrate how to escape societal collapse from natural resource scarcity in the developing countries.

The story of Machakos District in Kenya as a model for avoiding societal collapse

In this section, we will identify and discuss the underlying factors that may have determined the avoidance of the Malthusian collapse or Geertzian involution of the society in Machakos District. As said, the focus is on relatively closed societies, by passing strongly externally driven cases such as those described by Conelly (1992), in which migrant farmers in the Philippines moved rapidly from unsustainable slash-and-burn agriculture to a sustainable system of terraced rice and fruit tree fields due to a road that connected them to a growing market and strong government interventions to protect forests. However, no society is ever fully closed. We will therefore distinguish between internal and external factors.

Based on Tiffen et al. (1994), Burger and Zaal (2009) and Murton (1999) determining factors behind the 'miracle of Machakos' can be grouped as follows:

Motivational evidence/information

Soil erosion (topsoil washed out, gullies forming, etc.) was easy to see by the Machakos society. In other words, images of Malthusian futures were easy to identify, and the Machakos society was never in a state of denial as so often happens in 'developing societies' especially with less visible problems such as pollution or climate change.

Capacitating knowledge

How to make terraces was thoroughly debated and experimented between government organisations, non-governmental organisations and the farmers themselves. In the colonial period, terracing was forced labour and much resented. After independence from colonial rule, people first dropped terracing but picked it up again, this time voluntarily and massively. Debates between scientists and farmers on the best system continued (the farmers' style won) but all the while, farmers knew perfectly how to do it. Additional elements such as agroforestry were sometimes more time-consuming to grasp but knowledge was never a real bottleneck.

Population density

Much emphasised by Tiffen et al. (1994), high population density was not only the problem but also the solution. High population density resulted in low transaction cost, spreading of ideas, high school attendance due to short walking distances, and so on.

Social organisation

The hills of Machakos had been a refuge area of the Akamba people against the Masai. Contrary to many other ethnic groups in 'developing societies', the Akamba look on their land as a place to stay and to invest in. Successful urban Akambas returned to the district after pensioning, then often starting new farming activities, e.g. an experimental orchard or fishpond. Terracing was surrounded by a community atmosphere that endorsed and stimulated the work, often performed collectively in labour exchange groups, going around working on the farms of all members. A final cultural factor is that the Akamba woman, although officially second in command to her husband, is not shy to run the farm whether he is in or out. She knows how to organise a female self-help group and add a male secretary to satisfy the higher-level institutions and politics. The relevance of this gender phenomenon is that all over the world (e.g. in micro-finance), female motivations tend to be more future-oriented.

Nearby urban growth

It is a one-hour drive from Machakos District to Nairobi, Kenya's rapidly growing capital. The city was a ready market for basically all of Machakos old and new products (maize, vegetables, fruit, milk, etc.) and supplier of its external inputs when needed (fertilizer, knowledge, ideas, equipment, etc.). In neo-Thünian terms, Machakos found itself in the expanding zone of intensive land use around Nairobi. Moreover, labour migration to the city supplied many households in the district with substantial remittances that could be invested in the farm. Nevertheless, Murton (1999) is adamant on the urban factor in the miracle of Machakos: "Wealth comes from the city".

World market growth and connections

Good connections with traders and proximity of an airport enabled Machakos farmers to participate enthusiastically in the global coffee boom of the 1960s, bringing much income to the district. Later, Machakos beans and other vegetables found their way to European supermarkets.

In this list, factors 5 and 6 are external, and it is quite

likely that Tiffen et al. (1994) neo-Boserupian enthusiasm for internal factors, that is, a society taking itself out of poverty, is not free of bias. We also find a mixture of internal and external factors in the conclusions of Turner et al. (1993), based on studies of twelve cases of successful, sustainable agricultural intensification throughout the 'developing societies' of Africa. Many of those are less spectacular than Machakos District, but they all represent Boserupian and neo-Boserupian pathways of farming regions under population pressure.

At this point it may be worthwhile to take a brief look at the well-known collapse and sustainability factors to natural resources (Diamond, 2005). On the collapse side, Diamond mentions population, resource scarcity and climate change, followed by one positive external factor (trade relations that bring wealth and ideas), one negative external factor (especially welfare, exhausting society), and finally the response of society to resource scarcity. The sustainability factors elaborate on the latter in particular, focusing on timely knowledge and internalisation of the problem, leadership and rapid investments in solutions. So, in all this, what can 'developing societies' learn from the Machakos?

Suggested pathways to escape societal collapse due to natural resource scarcity

On the basis of lessons learnt from the Machakos "success" story, several suggestions can be drawn to avoid the population catastrophe's theory driven by natural resources scarcity. Some scholars have pointed out that the failure of western societies were driven by poor behavior assessment and understanding of the natural environment, as well as lack of long term vision and/or institutions. The lack of accountability of those factors could have played a crucial role in the collapse of historical civilizations. To avoid the collapse of historical civilizations, Good and Reuveney (2009) have suggested considering a theory based on endogenous population growth and renewable resources, as well as employing components of modern optimal social resource management/growth. In other words, they encourage that society should be built around a family of social welfare functions and appropriate policy instruments from the perspective of moral philosophy as well as a society driven by complete information flow, full understanding of the operating forces, infinite foresight, and efficient social institutions.

Arguing critically on Good and Reuveney's (2009) model of society collapse avoidance, it can be emphasized that in such a model of society, policy-makers and state managers have full knowledge of the advantages and disadvantages of taking a given decision for the benefit of the society as a whole. This implies that the manager's decision should rather lead to maximize or aggregate utility for the benefits of the whole society (Gross national product (GNP) rather than for maximizing the individual utility (equivalent to GNP per capita). In that regard, the manager has to take care of the benefits of the future generations by using a discount rate between almost 0 and 10 per cent. Failing to achieve that will more likely lead to the collapse of almost all model runs highlighted above.

The latter viewpoint is somehow controversial because some scholars have found that societies that prefer individual utility over aggregate utility tend to perform better. This has to do with the fact that societies focusing on promoting individual utility tend to lower population as a component in their utilitarian function. Even if these societies avoid collapsing, their collapse avoidance is relatively at a low discount rate levels estimated around 0.1%. This discount rate level is lower than the daily discount rate of people and from the 'social discount rate which is usually estimated at 5% (Arrow and Lind, 2014). The latter daily discount rate is used by governments in the cost-benefit analyses of public investments.

Focusing only on the discount rate's application, escaping from the societal collapse seems a hopeless solution. But if the focus is shifted to noneconomic attributes, the situation seems hopeful. People give to charities, decide to marry, and invest in their communities and in their children without involving cost-benefit and discount reasoning. Governments do the same when they establish human rights and workplace safety regulations and when they invest in healthcare systems, biodiversity conservation or, for that matter, the army. The decision-making pattern we encounter here goes under many names such as 'safe minimum standard' or 'two-tiered value theory' (De Groot, 1992). The basic notion of all of them is that we have to decide on fundamental and equity issues first, using our deliberative institutions, and only then decide on our efficiency issues, e.g. through markets and cost-benefit analyses that apply discount rates.

As Good and Reuveney (2009) put it, collapse is economically rational. This can be illustrated by visualising that at a discount rate of 7%, having a 3 US$ meal now that burdens future generations (100 years) with a cost of 2,600 US$ is economically rational, even desirable, because 3 times 1.07 to the power of 100 is more than 2,600. Such long-term discounting is sometimes justified by the assumption that future generations will be richer than ours, that is, they will have no problem putting up the 2,600 dollar compensating our meal. We find this assumption difficult to maintain. Thus we side with such authors as Voinov and Farley (2007), who feel that fundamental long-term issues should be decided without the application of discount rates. This outcome puts the decision-making level of natural resources management investments in 'developing societies' squarely in the first, non-economic tier.

Of course it has to be mentioned that the response to the challenge of natural resources scarcity, interlinked as

it is with fundamental and system-level institutions is an inherently slow process. This strongly reinforces the general risk that on the way down from moderate to severe resource scarcity, motivations for environmental recovery in 'developing societies' may rise but they will require an ever-larger part of national gross domestic product (GDP). This, as we have seen, is because rehabilitation is usually much more costly than timely protection. Therefore, even though 'developing societies' do not currently need much new science and technology on the short term, there is need for massive effort to get existing knowledge on natural resources management across to the public, to business and public leaders and to key institutions, in ways that really motivate people to take remedial action. On the latter, Nobel prize winner Kahneman (2011) informs us that people act on stories to which they can connect, not on deliberation. Natural resources management information in 'developing societies' will have to be repacked into stories that show for example how natural resource scarcity will affect children's lives.

On the other hand, the need for investment in technological and institutional change is eminent in all literature. Maybe in land management, energy systems, fisheries or forest management, the efforts will have to be massive. These investments should not be looked at through a merely economic lens. Before economics come in, commitments need be political, expressing the universally human capacity to move for the common good of sustainably managing natural resources. This necessitates the creation of and defence for common good institutions by the political and economic elites at any level of society. The success of 'developing societies' will increasingly depend on political leaders and economic elites that build and defend common good institutions. According to Turner et al. (1993), the earth is a refuge for its inhabitants, not merely a marketplace.

CONCLUSIONS

Developing countries will continue to face the issue of natural resources scarcity that concurrently threaten the livelihoods of the growing human populations. However, the situation is not hopeless since human beings have the capacity to adapt and innovate in ways of survival as initially suggested by Malthus and the Neo-Malthus population based theories. Contrary to the latter theories, the Geertzian, Boserupian; Neo-Boserupian and the Machakos District in Kenya have all evidenced that societies in developing countries need to be motivated, socially well-organised and possess capacitating knowledge to act positively. Such positive action would make societies in developing countries to successfully: i) utilise the available workforce and opportunities, and ii) take economic and noneconomic decisions based on natural resources management. Avoiding societal collapse of developing societies calls for crafting and investing in institutional building. Such institutional construction may successfully lead to the preservation of a healthy planet that will continue to provide for its inhabitats and sustain the livelihoods of the billions of human beings who depend on it.

Conflict of interest

There was no financial/relevant interest that may have influenced this study.

REFERENCES

Arrow KJ, Lind RC (2014). Uncertainty and the evaluation of public investment decisions. J. Nat. Resour. Policy Res. 6(1):29-44.

Boserup E (1965). The Conditions for Agricultural Growth. Aldine Publishing Company: New York.

Brox O (1990). The common property theory: Epistemological status and analytical utility. Hum. Organ. 49:227-235.

Butzer KW, Endfield GH (2012). Critical perspectives on historical collapse. PNAS 109(10):3628-3631.

Conelly WT (1992). Agricultural intensification in a Philippine frontier community: Impact on labour efficiency and farm diversity. Hum. Ecol. 20(2):203-223.

De Groot WT (1992). Environmental science theory. Elsevier Science Publishers: Amsterdam, P 253. Available online at https://openaccess.leidenuniv.nl/handle/1887/11548

De Groot WT (2003). Thünian land use theory, visions of nature, and the Future of the Sierra Madre Forest. The Sierra Madre Mountain Range: Global Relevance, Local Realities, 361 p.

Diamond J (2005). Collapse: How societies choose or fail to survive. Penguin Press: London.

FAO-Food and Agriculture Organization of the United Nations (2010b). Fisheries and Aquaculture Statistics. Food and Agricultural Organisation of the United Nations, Rome. Available online at http://www.fao.org/docrep/015/ba0058t/ba0058t.pdf

FAO-Food and Agriculture Organization of the United Nations. (2010a). Global forest resources assessment 2010: Main report. Rome, Italy. Available online at http://www.fao.org/docrep/013/i1757e/i1757e.pdf

Geertz C (1963). Agricultural involution: The processes of ecological change in Indonesia. University of California Press: Berkeley, USA.

Gellner E (2006). Nations and nationalism. Blackwell: Oxford, UK.

Good DH, Reuveney R (2009). On the collapse of historical civilizations. Am. J. Agric. Econ. 91(4):863-879.

Hobbes M, De Groot WT, Van der Voet E, Sarkhel S (2011). Freely disposable time: A time and money integrated measure of poverty and freedom. World Dev. 39(12):2055-2068.

Homer-Dixon TF (1999). Environment, scarcity, and violence. Princeton University Press: Princeton, USA.

Kahneman D (2011). Thinking, fast and slow. Penguin Books: London.

Lele SM (1991). Sustainable development: a critical review. World Dev. 19(6):607-621.

Lovelock J (2006). The revenge of Gaia. Basic Books: New York.

Malthus TR (1798). An essay on the principle of population. Murray: London. Reprinted for instance in Nelissen N, Van Straaten, Klinkers L (Eds.) Classics in Environmental Studies, International Books: Utrecht, pp. 29-38.

Murton J (1999). Population growth and poverty in Machakos District, Kenya. Geogr. J. 165(1):37-46.

Nankhuni FJ, Findeis JL (2004). Natural resource-collection work and children's schooling in Malawi. Agric. Econs. 31(2-3):123-134.

Place F, Otsuka K (2001). Population, tenure, and natural resource management: The case of customary land area in Malawi. J. Environ. Econ. Manage. 41(1):13-32.

Sunderlin WD, Angelsen A, Belcher B, Burgers P, Nasi R, Santoso L, Wunder S (2005). Livelihoods, forests, and conservation in developing , countries: An overview. World Dev. 33(9):1383-1402.

Tiffen M, Mortimore M, Gichuki F (1994). More people less erosion: Environmental recovery in Kenya. Wiley: Chichester, UK.
Turner BL, Ali AS (1996). Induced intensification: Agricultural change in Bangladesh with implications for Malthus and Boserup. PNAS 93(25):14984-14991.
Turner BL, Hydén G, Kates RW (1993). Population growth and agricultural change in Africa. University Press of Florida: Gainesville, USA.
United Nations (2015). World population prospects: The 2015 revision. Department of Economic and Social Affairs, Population Division, United Nations: New York. Available online at http://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf
Voinov A, Farley J (2007). Reconciling sustainability, systems theory and discounting. Ecol. Econ. 63:104-113.
Wilkinson RG (1973). Poverty and progress: An ecological model of economic development. Methuen and Co. London, UK.
Wunder S, Engel S, Pagiola S (2008). Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. Ecol. Econ. 65(4):834-852.
Zulu LC (2010). The forbidden fuel: Charcoal, urban wood fuel demand and supply dynamics, community forest management and wood fuel policy in Malawi. Energy Policy 38(7):3717-3730.