ISSN 1327-8231

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 180

Biodiversity Change and Sustainable Development: New Perspectives

by

Clem Tisdell

June 2012

THE UNIVERSITY OF QUEENSLAND

ISSN 1327-8231

WORKING PAPERS ON

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 180

Biodiversity Change and Sustainable Development: New Perspectives[1]

by

Clem Tisdell[2]

June 2012

---

[1] The draft of a contribution to an edited volume, *Biodiversity Conservation: New Research* being published by Nova Science Publishers, New York.

[2] School of Economics, The University of Queensland, St. Lucia Campus, Brisbane QLD 4072, Australia
Email: c.tisdell@economics.uq.edu.au

WORKING PAPERS IN THE SERIES, *Economics, Ecology and the Environment* are published by the School of Economics, University of Queensland, 4072, Australia, as follow up to the Australian Centre for International Agricultural Research Project 40 of which Professor Clem Tisdell was the Project Leader. Views expressed in these working papers are those of their authors and not necessarily of any of the organisations associated with the Project. They should not be reproduced in whole or in part without the written permission of the Project Leader. It is planned to publish contributions to this series over the next few years.

Research for ACIAR project 40, *Economic Impact and Rural Adjustments to Nature Conservation (Biodiversity) Programmes: A Case Study of Xishuangbanna Dai Autonomous Prefecture, Yunnan, China* was sponsored by the Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT, 2601, Australia.

The research for ACIAR project 40 has led in part, to the research being carried out in this current series.

<u>For more information</u> write to Emeritus Professor Clem Tisdell, School of Economics, University of Queensland, St. Lucia Campus, Brisbane 4072, Australia.

Biodiversity Change and Sustainable Development: New Perspectives

ABSTRACT

Biodiversity is usually regarded as an asset or resource, the stock of which is partly natural and partly determined by humans. Humans both subtract from and add to this stock and consequently, the change in the stock is heterogeneous. This heterogeneity is not taken account of by some authors who focus only on the loss aspect. Frequently, the conservation of this stock is seen as important for the achievement of sustainable development; sustainable development being defined (but not always acceptably) as a situation on which the welfare of each future generation is no less than that of its preceding generation. Definitions of biodiversity are quite wide but here its focus is restricted to genetic diversity. Humans alter the stock of genetic diversity by eliminating some species or varieties of these and also add to this stock by selective breeding and genetic engineering. Both direct and indirect human impacts on diversity occur. The types of possible changes in the genetic stock are classified in a simple manner. It is pointed out that not all the genetic stock has positive consequences for human welfare because some of the genetic material has negative consequences (e.g. pests) for humankind or for some groups of human beings. This can make its evaluation of the genetic stock difficult. Implications of additions to the genetic stock by human manipulation of it (e.g. by the development of GMOs and selective breeding) are given particular attention. This raises the question of how many future generations should be taken into account in making choices about biodiversity and the manner in which their welfare should be allowed for. For example, should discounting be applied? Also how much precaution is needed to allow for uncertainty, for example, is a safety first rule advisable? These issues are discussed.

Keywords: biodiversity conservation, economic mechanisms and biodiversity changes, genetic engineering, genetic stock alterations, sustainable development, valuation of genetic stock.

1. Introduction

There are concerns that loss of biodiversity may eventually result in economic development becoming unsustainable. This view is reflected, for instance, in the Millennium Economic Assessment (2005) and in the Economics of Ecosystems and Biodiversity (TEEB) Study which was designed 'to draw attention to the global economic benefits of biodiversity and to highlight the growing costs of biodiversity loss and ecosystem degradation' http://teebweb.org/. An output from the latter project includes the book *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations* (Kumar, 2010).

The stock of biodiversity represents partly a natural and partly a man-made resource, and as a whole, is an asset or form of capital because of the valuable ecosystem services which it supplies to humankind. Nevertheless, not all elements of biodiversity are valuable from a human perspective: some elements such as pests, those causing diseases, and 'hostile' ecosystems have negative value. For example, although the complete eradication of the organism causing smallpox would reduce biodiversity, other things held constant, it is a valuable reduction in the stock of biodiversity from a human perspective.

The type of factors taken into account in measuring biodiversity are wide. They include genetic diversity, ecosystem diversity, landscape diversity and other factors. In this chapter, the discussion focusses on genetic diversity. However, it is realized that genetic diversity depends on other dimensions of biodiversity such as ecosystem diversity, and in the longer term, is influenced by the diversity of niches (habitats) available for the support of life (Tisdell, 1999, Ch.4).

Initially, this chapter focuses on the categorisation or classification of the stock of genetic diversity according to whether the genetic material can be attributed primarily to human intervention or to natural processes. Then the nature of changes in the stock and the interaction between the human developed genetic stock and the wild stock is considered. Subsequently, economic mechanisms leading to loss or more generally, change in the genetic stock are discussed. Then the economic value of genetic diversity is examined and the potential intergenerational welfare consequences of genetic manipulation are explored in the dynamic context of sustainable development.

2. Classifying the Stock of Genetic Diversity and Changes in its Composition

The stock of genetic material can be classified in many different ways. Currently, the dominant method of classification of living organisms is biological classification; a part of scientific taxonomy. It classifies organisms by biological type, such as species, genus and family (Anon, 2011a). Although the origin of such classification is usually ascribed to the work of Carolus Linnaeus, biological classifications continue to be revised with advances in scientific knowledge. The genetic classifications used here are not biologically based but are intended to reflect the extent to which genetic material depends on human beings for its existence and survival or does not do so. Earlier attempts to develop the systematics of this type can be found in Tisdell (2005, pp. 149-150, 2009).

Two different classifications of this type are possible. These are: (1) whether or not the genetic material would have come into existence without deliberate human effort to develop it, and (2) whether or not the genetic material requires continuing human management for its survival or is able to continue to survive without such assistance. Consider the first classification to begin with.

This classification may not be exhaustive because some genetic material can evolve incidentally as a result of human-induced environmental changes and the continuing existence of that genetic material often depends on humans maintaining that environmental change. However, ignoring this case, the set of extant genetic material is represented by that due to human effort, H, and that which has evolved independently of human effort, W. This is represented by the top set in Figure 1, the elements of which identify different types of genetic material. As a result of growing human activity (primarily reflected in economic growth), it is acknowledged that both prior genetic diversity developed by humans and wild genetic diversity is declining. If the set of genetic material available at earlier date (say 100 years ago) is compared with this set at a later date (say now), the set and its components shrink. Thus, in Figure 1, the initial genetic self H (human developed genetic material) plus W (genetic material produced in the wild) shrinks after some time to a smaller set, H′ plus W′. Consequently, there is an unequivocal reduction in the pre-existing stock of genetic material and in that sense, biodiversity loss clearly occurs on a global scale.

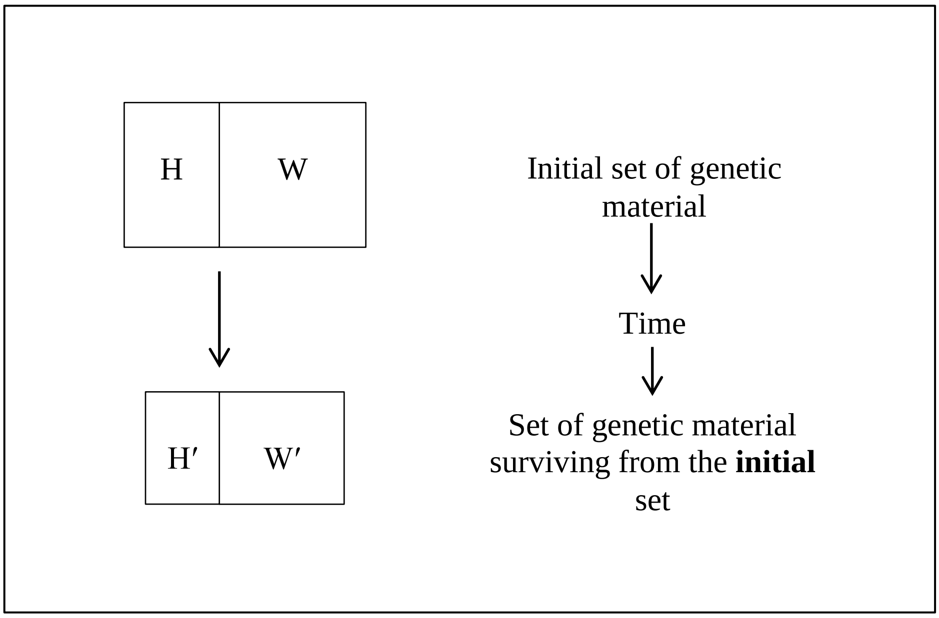

Figure 1: With the passage of time, the set of genetic material surviving from the initial set shrinks. This is true on a global scale for human developed genetic material as well as for genetic material developed in the wild.

However, Figure 1 does not fully capture the dynamics of human-induced impacts on the stock of genetic material because in a relatively short-period of time, humans are able to develop new genetic material (that is organisms unlikely to evolve in the wild) and in some cases, organisms unable to survive in the wild. With the advent of genetic modifications of organisms and genetic engineering, the scope for human development of new organisms has expanded considerably compared to the earlier process of human selection by breeding and culture of genetic material. The speed of human development of genetic material has now accelerated. Furthermore, it is now possible to explore many permutations of genetic material which are unlikely to occur in the absence of genetic engineering. Therefore, Figure 1 needs to be modified to allow for human additions to the genetic stock. Note: it is assumed that for this time-period involved no evolution occurs in the wild stock but if it does, it can be allowed for.

One possibility is illustrated by Figure 2. There the top set represents the initial genetic stock. Now suppose that humans add to this stock a set A. In the immediate period of the addition, and possibly for some time, the global sock of genetic material increases. This is because it takes time for added genetic material to reduce the pre-existing genetic stock, if in fact, it will do that. Depending on the nature of the added genetic material, the added genetic stock may subsequently (eventually) reduce the pre-existing human developed genetic stock as well as the pre-existing wild genetic stock. Thus, both the set H and the set W could become smaller. In the case illustrated in Figure 2 by the bottom set, it is assumed that the hatched area is lost from the human developed global genetic stock and the dotted area is lost from the genetic stock in the wild so that apart from set A (which is a part of the human developed genetic stock), the surviving pre-existing stocks are reduced from H to H′ and from W to W′.

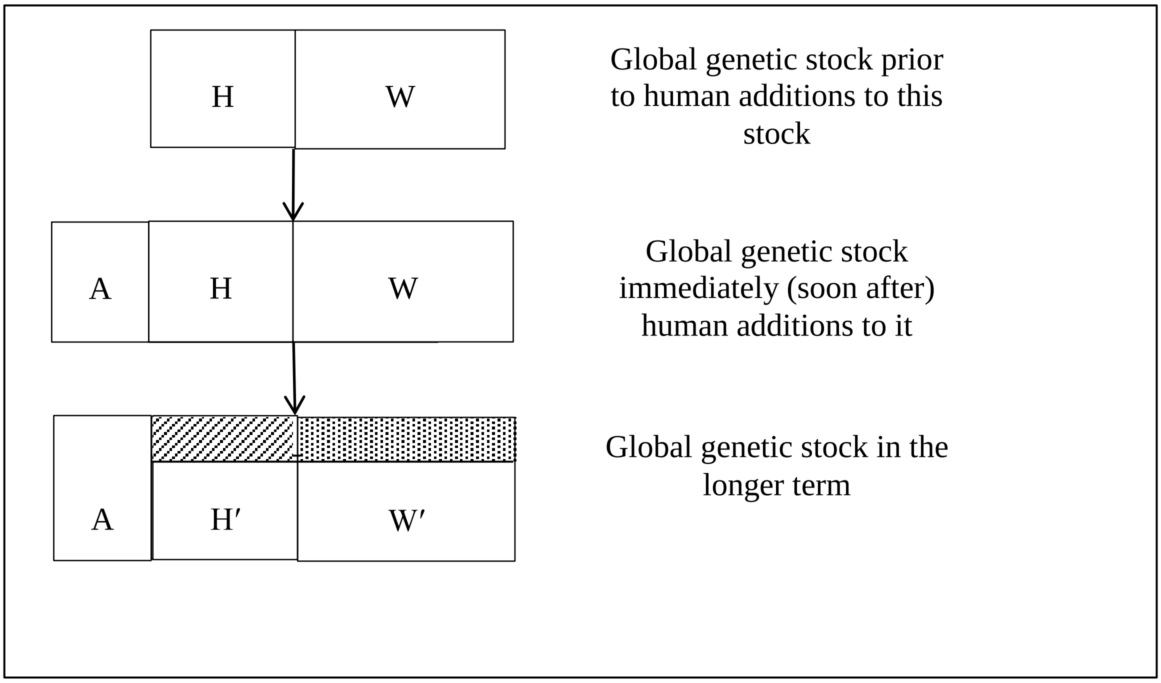

Figure 2 Possible consequences for the size of the genetic stock of human introductions of new combinations or types of genetic material. The hatched and dotted areas indicate lost genetic stock.

It is, of course, conceivable that the introduction of new genetic material into the genetic stock will neither reduce the global pre-existing stock of human developed genetic material nor result in loss of genetic material that has evolved in the wild. In that case, the genetic stock would actually expand. However, in many cases (possibly most) some reduction in the pre-existing genetic stock is likely to occur. Some of the economic mechanisms involved are discussed in the next section.

We could also classify genetic material by whether or not it relies for its survival on human management or not, or by what amounts to the same thing, whether or not this material is able to survive in the wild. Much (but not all) of the genetic material developed by humans can only survive as a result of human management. However, there is always a risk that new genetic material (organisms) developed by humans may be able to exist in the wild independent of human management or may interbreed with existing wild or domestic organisms bringing about unwanted changes in the stock of genetic material.

It is difficult to predict the type of changes in the genetic stock that are likely to come about as the result of the introduction of a new organism into that stock, for example, as a result of genetic engineering. However, some indication of the range of possibilities can be obtained from experience with the introduction of exotic organisms into a country or region. These organisms may be domesticated, cultured or wild ones. Some may fail to survive at all in the new environment. Others may only survive as a result of human management, and others may survive and increase their populations in the wild. In cases where the exotic introductions survive, the pattern of change in the genetic stock is like that shown in Figure 2, where the exotic introductions correspond to set A, set H represents the human development stock in the region and W the wild evolved stock. At the beginning of the introduction, the stock of genetic material in the region does not alter because the organisms do not spread far beyond their point(s) of introduction initially. However, eventually these introductions may result in disappearance of some of the pre-existing human developed genetic stock or some of the wild genetic stock. For example, as a result of commercial decisions by farmers, the introduction of improved breeds of livestock or crops into developing countries often leads to a loss of local breeds and varieties of crops (Tisdell, 2003). Sometimes, introduced domestic animals escape and are able to survive in the wild displacing indigenous wild animals, as in the case of many feral animals in Australia e.g. dogs, cats, pigs, buffalo, goats and so on (see, for example, Tisdell, 1982). However, not all are capable of survival in the wild, for example, domesticated sheep in Australia. Furthermore, many examples exist of introduced exotic wild organisms becoming invasive and a threat to regional biodiversity (Anon, 2011b, Van Driesche and Van Driesche, 2004).

3. Economic Mechanisms Driving Changes in the Genetic Stock, Including Genetic Loss

In the contemporary world, a dominant influence on changes in the genetic stock is the drive for commercial gain or profit. This is the main factor resulting in reduced diversity of breeds of livestock (Tisdell, 2003) and crop varieties. A new livestock breed or crop variety able to yield a higher level of profit than an existing one or ones, will be preferred by farmers, if the demand for the produce of the alternative breeds or variables remaining unchanged. This replacement may occur even if the new organisms require a larger package of inputs to be more profitable, as is the case of high yielding varieties of rice and wheat (Alauddin and Tisdell, 1991). In effect, the introduction of the new organisms results in a change in available technology for economic production.

Figure 3 illustrates, using supply and demand analysis, the loss of one or more commercial breeds of livestock or crop varieties due to its replacement by a new breed or variety. Suppose that a product X is being produced commercially using existing organisms and that the industry supply curve for X using these organisms is as shown by line BS_1. This line represents the marginal cost of supplying X relying on these existing organisms for the production of X. The demand for product X is represented by line DF. Therefore, initially the market for X is in equilibrium at E_1 and X_1 of the product is supplied and it sells at P_2 per unit.

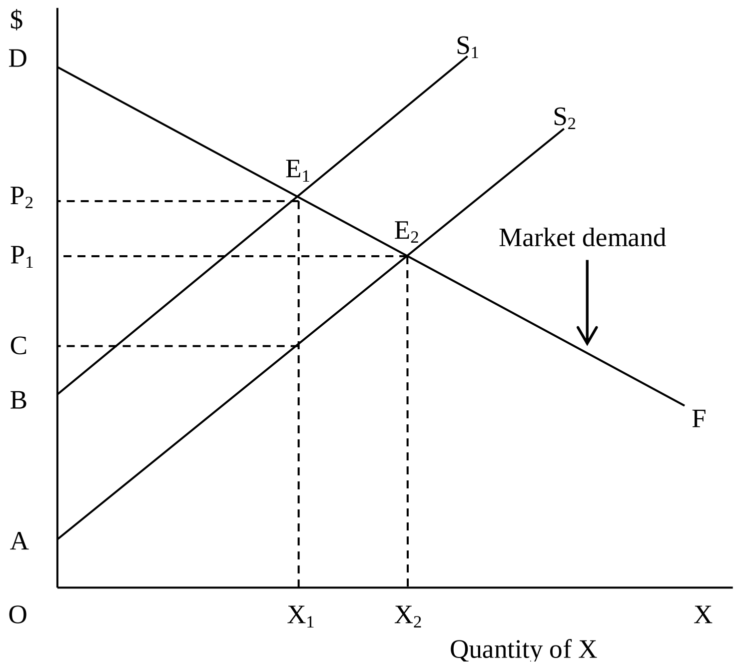

Figure 3 An illustration of the displacement of existing organisms by a 'new' organism able to produce a commercial product at a reduced cost.

Suppose now that a 'new' organism is developed that reduces the cost of producing product X and that as a result, the market supply relationship shifts from BS_1 to AS_2. Producers can now increase their profit by switching to the 'new' organism and eventually, other things being held constant, the new market equilibrium becomes E_2. Given that the continuing existence of the organisms previously used in producing X depends upon their commercial use, they will completely disappear and be replaced by the 'new' organism. The only way they might continue to survive ins by the actions of hobbyists and enthusiasts not motivated by profit.

Even if it were known that in the very long-term the new organism will be eventually less fit economically then one or more of the existing organisms, the desire for commercial gain will still most likely lead to the disappearance of the latter, given that future commercial benefits are discounted. In that case, no individual may gain economically for conserving any of the existing organisms, particularly if they do not have exclusive rights to the use of the conserved genetic material. In general, discounting tends to discourage decisions favouring sustainable development. Nevertheless, in a wider economic context, as pointed out by Tisdell (2011a), there is not a regular relationship between the level of the rate of interest and the speed of biodiversity loss. That is because the speed of this loss depends primarily on the rate of economic growth and the rate of capital accumulation, both of which are major contributors to biodiversity loss. When the rate of economic growth or the rate of capital accumulation is high, the rate of interest may be low or high, and vice versa (Tisdell, 2011a).

Other economic factors, such as those associated with globalisation, are also involved in global biodiversity, loss of cultured organisms and so on and are discussed in Tisdell (2003). Furthermore, economic forces are the major (but not the only causes) of biodiversity loss in the wild. They result, for example, in the loss of habitats of wild species and the introduction of exotic species and organisms; major contributors to global biodiversity loss. A recent example of such losses is the effects of the expansion of oil palm plantations in tropical countries resulting in loss of tropical forests and their biodiversity; for instance, threatening the continuing existence of forest dependent species such as the orangutan (Swarna Nantha and Tisdell, 2009, Tisdell and Swarna Nantha, 2008).

4. The Economic Value of the Genetic Stock and Implications of its Composition for Sustainable Development

While it is usually suggested that a high degree of biodiversity is an economic asset because it helps in coping with uncertainty by increasing flexibility in decision making and may increase the resilience and robustness of ecosystems, not all additions or components of biodiversity are valuable from a human perspective. Some organisms have negative worth or are pests from a human perspective. Some have both positive and negative impacts on human beings, such as wild pigs (Tisdell, 1982). In these cases, it is necessary to assess their overall value to human beings (Tisdell, 2002, Ch. 12). However, in assessing the value of an organism from a human perspective, it is necessary to take into account its indirect impacts (which can be positive) as well as direct impacts on other living things. Nevertheless, even if some of its indirect effects are of positive value, it could still be that this organism has a negative value overall. For instance, even if a 'pest' contributes to the resilience of an ecosystem, the extent to which it does this may not fully compensate for the damages it causes, the assessment being based on anthropocentric values.

The possibility also needs to be considered that loss of biodiversity could lead to unsustainable development and eventually, to impoverishment of future generations (Tisdell, 2011b). This is of concern because extinction cannot be reversed, or arguably cannot be reversed so easily.

This problem is illustrated in Figure 4. There line CFG represents the well-being that members of existing and future generations can achieve using the existing stock of genetic material. This stock enables sustainable development to be achieved assuming that the horizon for the human race ends at t_n. Sustainable development is achieved in the sense that the well-being of human beings never declines. In fact, in the case illustrated, it continually rises. However, suppose that the existing set of genetic material can be replaced by another set which gives a higher level of well-being to generations near the present ones but a lower level of welfare to generations more distant from the present. This is represented by curve CDE in Figure 4. Current generations are likely to be tempted to replace the existing set of genetic material by the new set (which may include genetically engineered organisms) because this benefits the generations in which current generations have the greatest interest or are most concerned about. According to Pearce (1998, p.71) current generations are mostly interested in their own welfare and that of their children and their grandchildren. It may even be the sum of human well-being (if it can be measured) will be greater over the interval $0 < t < t_n$ than if the existing genetic stock is replaced rather than conserved. However, all generations after t_2 will be worse off than current generations. Furthermore, if OA represents a level of well-being below which impoverishment occurs, all generations after t_3 will be impoverished? Of course, there is uncertainty about whether this unfortunate scenario will happen but the possibility of this occurring cannot be dismissed. Some of the issues involved are given additional consideration in Tisdell (2011b).

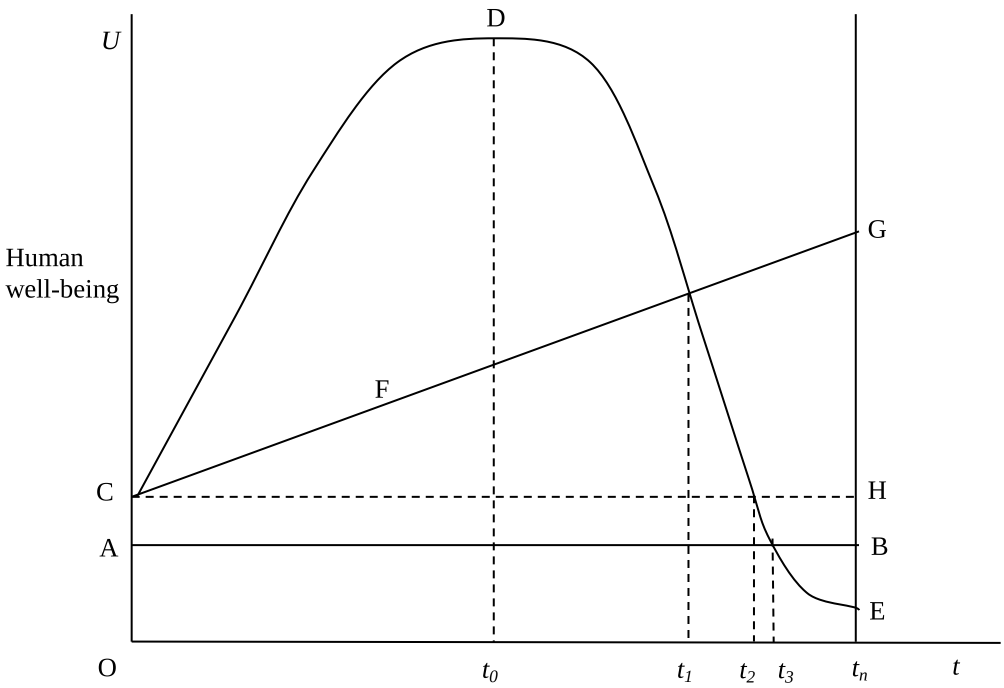

Figure 4 Possible consequence for the intergenerational well-being of human beings of a change in the stock of genetic material brought about by human action.

There are of course, other theoretical possibilities:

1. For example, after reaching point D, the curve CDE might continue to rise. This is a very favourable case because all generations are better off as a result of the change in the stock of biodiversity, and each succeeding generation is better off than its predecessor.
2. The curve CDE might still reach its maximum at D and then decline to a level above G. All future generations are better off than they would have been in the absence of a change in the genetic stock but after t_0, each generation is less well off than its predecessor.
3. Another possibility is that curve CDE declines after D but its end-point is between G and H. In this case, distant generations are worse off than they would have been

had the existing genetic stock remained unaltered. Nevertheless, they are better off than the earliest generations.

4. In this case, CDE reaches its maximum at D but its end-point, E, is between H and B. In this case, the most distant generations are worse off than the earliest generations but they are not impoverished, which would be the case if end-point E is below B.

Thus, theoretically it can be seen that several different types of development paths are possible when the stock of genetic material is altered. Given the very long time-periods involved in planning for sustainable development and our current lack of knowledge, the actual development path that will prevail is difficult or impossible to predict. Hence, the long-term impacts of changing the genetic stock remain uncertain (Tisdell, 2010;2011b;forthcoming) thereby making it difficult to choose optimal policies for regulating changes in this stock. The problem is reduced (but not eliminated) if planning for economic development or sustainable development is only to take into account the well-being of the next two or three generations, as Pearce (1998, p.75) suggests is probably the limit of the practical concern of present generations in considering desirable patterns of economic development.

Consequently, plans to achieve sustainable development are unlikely to cover a span of time much more than a 100 years into the future. Probably in most cases, the planning time-horizon for most development decisions is much shorter. Whether or not that ought to be the span of practical concern for future generations is a different matter.

5. Conclusion

While existing genetic material (both that developed by humans and developed in the wild) is lost with the passage of time, some new genetic material is also added. The speed at which this addition can be done has accelerated with the emergence of genetic modification and genetic engineering. This new genetic material frequently displaces some of the stock of pre-existing genetic material, partly for economic reasons. Economic processes are major influences on changes in the genetic stock, including loss of existing genetic stock. The desire of farmers, and others, to increase their profit is a major influence on biodiversity loss and gain, and because businesses usually discount future profit, the sustainability of profit is not a significant consideration in business decisions about changes in the genetic stock.'

It is frequently argued that a loss in the genetic stock reduces biodiversity and, for various reasons, is an overall disadvantage to mankind. However, this does not take account of the fact that some organisms have on overall a negative value from a human point of view. In assessing this, it is nevertheless necessary not just to take into account the immediate effects of an organism but to be aware of its indirect functions within ecosystems. The fact that organisms have some positive effects, for example, help to stabilize ecosystems, is not sufficient to justify their continuing existence from a selfish human point of view.

The stock of genetic material is known to have implications for the sustainability of economic development and for development possibilities generally. Several theoretical possibilities have been identified in this chapter. It is quite possible for some changes in the stock of genetic material to result in unsustainable economic development and to lead eventually to impoverishment of future generations. However, given the long time-periods involved and the extent of our knowledge, it is impossible to predict confidently the development path that can be expected to prevail. If it is true that in practice, human policy and planning only encompasses concern for the next two or three generations, predictions for this shorter time period are likely to be more accurate, but not perfect. Therefore, humankind is taking significant (but to a large extent unknown risks) in deliberately or accidentally altering the global genetic stock. Whether it is worth the risk is not yet resolved.

References

Alauddin, M. and Tisdell, C. A. (1991). *The 'Green Revolution' and Economic Development: The Process and its Impact in Bangladesh.* Macmillan, London.

Anon (2011a). Biological classification. *Wikipedia*. Retrieved 17 November, 2011 from http://en.wikipedia.org/wiki/Biological_classification

Anon (2011b). Invasive Species. *Wikipedia*. Retrieved 21 November, 2011 from http://en.wikipedia.org/wiki/Invasive_Species

Kumar, P. (Ed.) (2010). *The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations*. Earthscan, London and Washington, DC.

Millennium Ecoysystem Assessment (2005). *Ecosystems and Human Well-being: Biodiversity Synthesis*. World Resources Institute, Washington, DC.

Pearce, D. W. (1998). *Economics and Environment: Essays on Ecological Economics and Sustainable Development.* Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Swarna Nantha, H. and Tisdell, C. A. (2009). The orangutan-oil palm conflict: economic constraints and opportunities for conservation. *Biodiversity Conservation*, **18**, 487-502.

Tisdell, C. A. (1982). *Wild Pigs: Environmental Pest or Economic Resource?* Pergamon Press, Sydney, Oxford, New York.

Tisdell, C. A. (1999). *Biodiversity, Conservation and Sustainable Development: Principles and Practices with Asian Examples.* Edward Elgar, Cheltenham, UK.

Tisdell, C. A. (2002). *The Economics of Conserving Wildlife and Natural Areas.* Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Tisdell, C. A. (2003). Socioeconomic causes of loss of animal genetic diversity: analysis and assessment. *Ecological Economics*, **45**, 365-376.

Tisdell, C. A. (2005). *Economics of Environmental Conservation.* Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Tisdell, C. A. (2009). *Resource and Environmental Economics: Modern Issues and Applications.* World Scientific, Singapore, Hackensack New Jersey, London.

Tisdell, C. A. (2010). The precautionary principle revisited: its interpretations and their conservation consequences. *Singapore Economic Review*, **55**, 335-352.

Tisdell, C. A. (2011a). Biodiversity conservation, loss of natural capital and interest rates. *Ecological Economics*, **70**, 2511-2515.

Tisdell, C. A. (2011b). Core issues in the economics of biodiversity conservation. *Annals of the New York Acadamy of Sciences*, *Ecological Economics Reviews.* **1219**, 99-112. R. Costanza, Karin Limburger and Ida Kubiszewski, Eds.

Tisdell, C. A. (forthcoming). Economics, ecology and GMOs: sustainability, precaution and other issues. In M. A. Quaddus and M. A. B. Siddique, (eds), *Handbook of Sustainable Development Planning* 2nd Edn. Edward Elgar, Cheltenham, UK and Northampton, MA, USA.

Tisdell, C. A. and Swarna Nantha, H. (2008). Conservation of the proboscis monkey and the orangutan in Borneo: Comparative issues and economic considerations. Pp. 225-250 In V. K. Gupta and A. K. Verma, (eds), *Perspectives in Animal Ecology & Reproduction* Vol. 5. Daya Publishing House, Delhi.

Van Driesche, J. and Van Driesche, J. (2004). *Nature Out of Place: Biological Invasion in the Global Age.* Island Press, Washington, DC.

PREVIOUS WORKING PAPERS IN THE SERIES
ECONOMICS, ECOLOGY AND ENVIRONMENT

For a list of working papers 1-100 in this series, visit the following website: http://www.uq.edu.au/economics/PDF/staff/Clem_Tisdell_WorkingPapers.pdf or see lists in papers 101 on.

101. Knowledge and Willingness to Pay for the Conservation of Wildlife Species: Experimental Results Evaluating Australian Tropical Species, by Clem Tisdell and Clevo Wilson, May 2004.
102. Antarctic Tourists, Wildlife and the Environment: Attractions and Reactions to Antarctica, by Clem Tisdell, May 2004.
103. Birds in an Australian Rainforest: Their Attraction for Visitors and Visitors' Ecological Impacts, by Clem Tisdell and Clevo Wilson, May 2004.
104. Nature-Based Tourism and the Valuation of its Environmental Resources: Economic and Other Aspects by Clem Tisdell, May 2004.
105. Glow Worms as a Tourist Attraction in Springbrook National Park: Visitor Attitudes and Economic Issues, by Clem Tisdell, Clevo Wilson and David Merritt, July 2004.
106. Australian Tropical Reptile Species: Ecological Status, Public Valuation and Attitudes to their Conservation and Commercial Use, by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, August 2004.
107. Information and Wildlife Valuation: Experiments and Policy, by Clem Tisdell and Clevo Wilson, August 2004.
108. What are the Economic Prospects of Developing Aquaculture in Queensland to Supply the Low Price White Fillet Market? Lessons from the US Channel Catfish Industry, by Thorbjorn Lyster and Clem Tisdell, October 2004.
109. Comparative Public Support for Conserving Reptile Species is High: Australian Evidence and its Implications, by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, October 2004.
110. Dependence of public support for survival of wildlife species on their likeability by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, October 2004.
111. Dynamic Processes in Contingent Valuation: A Case Study Involving the Mahogany Glider by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, November 2004.
112. Economics, Wildlife Tourism and Conservation: Three Case Studies by Clem Tisdell and Clevo Wilson, November 2004.
113. What Role Does Knowledge of Wildlife Play in Providing Support for Species' Conservation by Clevo Wilson and Clem Tisdell, December 2004.
114. Public Support for Sustainable Commercial Harvesting of Wildlife: An Australian Case Study by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, December 2004.
115. Endangerment and Likeability of Wildlife Species: How Important are they for Proposed Payments for Conservation by Clem Tisdell, Hemanath Swarna Nantha and Clevo Wilson, December 2004.
116. How Knowledge Affects Payment to Conserve and Endangered Bird by Clevo Wilson and Clem Tisdell, February 2005.
117. Public Choice of Species for the Ark: Phylogenetic Similarity and Preferred Wildlife Species for Survival by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, March 2005.
118. Economic Incentives for Global Conservation of Wildlife: New International Policy Directions by Clem Tisdell, March 2005.
119. Resource Entitlements of Indigenous Minorities, Their Poverty and Conservation of Nature: Status of Australian Aborigines, Comparisons with India's Tribals, Theory and Changing Policies Globally by Clem Tisdell, March 2005.

120. Elephants and Polity in Ancient India as Exemplified by Kautilya's *Arthasastra* (Science of Polity) by Clem Tisdell, March 2005.
121. Sustainable Agriculture by Clem Tisdell, April 2005.
122. Dynamic Processes in the Contingent Valuation of an Endangered Mammal Species by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, April 2005.
123. Knowledge about a Species' Conservation Status and Funding for its Preservation: Analysis by Clem Tisdell, June 2005.
124. Public Valuation of and Attitudes towards the Conservation and Use of the Hawksbill Turtle: An Australian Case Study by Clem Tisdell, Hemanath Swarna Nantha and Clevo Wilson, June 2005.
125. Comparison of Funding and Demand for the Conservation of the Charismatic Koala with those for the Critically Endangered Wombat *Lasiorhinus krefftii* by Clem Tisdell and Hemanath Swarna Nantha, June 2005.
126. Management, Conservation and Farming of Saltwater Crocodiles: An Australian Case Study of Sustainable Commercial Use by Clem Tisdell and Hemanath Swarna Nantha, August 2005.
127. Public Attitudes to the Use of Wildlife by Aboriginal Australians: Marketing of Wildlife and its Conservation by Clem Tisdell and Hemanath Swarna Nantha, August 2005.
128. Linking Policies for Biodiversity Conservation with Advances in Behavioral Economics by Clem Tisdell, August 2005.
129. Knowledge about a Species' Conservation Status and Funding for its Preservation: Analysis by Clem Tisdell, August 2005.
130. A Report on the Management of Saltwater Crocodiles (*Crocodylus porosus*) in the Northern Territory: Results of a Survey of Pastoralists by Clem Tisdell, Clevo Wilson and Hemanath Swarna Nantha, September 2005.
131. Crocodile Farms and Management of Saltwater Crocodiles in Northern Territory: Results of a Survey of NT Crocodile Farmers Plus Analysis of Secondary Information by Clem Tisdell, September 2005.
132. The Environment and the Selection of Aquaculture Species and Systems: An Economic Analysis by Clem Tisdell, October 2005.
133. The History and Value of the Elephant in Sri Lankan Society by Ranjith Bandara and Clem Tisdell, November 2005.
134. Economics of Controlling Livestock Diseases: Basic Theory by Clem Tisdell, November 2006.
135. Poverty, Political Failure and the Use of Open Access Resources in Developing Countries by Clem Tisdell, November 2006.
136. Global Property Rights in Genetic Resources: An Economic Assessment by Clem Tisdell, November 2006.
137. Notes on the Economics of Fish Biodiversity: Linkages between Aquaculture and Fisheries by Clem Tisdell, November 2006.
138. Conservation of the Proboscis Monkey and the Orangutan in Borneo: Comparative Issues and Economic Considerations by Clem Tisdell and Hemanath Swarna Nantha, March 2007.
139. Economic Change and Environmental Issues: Policy Reforms and Concerns in Australian Agriculture, by Clem Tisdell, April 2007.
140. Institutional Economics and the Behaviour of Conservation Organizations: Implications for Biodiversity Conservation by Clem Tisdell, March 2007
141. Poverty, Policy Reforms for Resource-use and Economic Efficiency: Neglected Issues by Clem Tisdell, May 2007.
142. The State of the Environment and the Availability of Natural Resources by Clem Tisdell, May 2007.
143. Economics of Pearl Oyster Culture by Clem Tisdell and Bernard Poirine, July 2007.

144. The Economic Importance of Wildlife Conservation on the Otago Peninsula – 20 Years on by Clem Tisdell, November, 2007.
145. Valuing the Otago Peninsula: The Economic Benefits of Conservation by Clem Tisdell, November 2007.
146. Policy Choices about Agricultural Externalities and Sustainability: Diverse Approaches, Options and Issues by Clem Tisdell, November, 2007.
147. Global Warming and the Future of Pacific Island Countries by Clem Tisdell, November 2007.
148. Complex Policy Choices about Agricultural Externalities: Efficiency, Equity and Acceptability by Clem Tisdell, June 2008.
149. Wildlife Conservation and the Value of New Zealand's Otago Peninsula: Economic Impacts and Other Considerations by Clem Tisdell, June 2008.
150. Global Property Rights in Genetic Resources: Do They Involve Sound Economics? Will They Conserve Nature and Biodiversity? By Clem Tisdell, August 2008.
151. Supply-side Policies to Conserve Biodiversity and Save the Orangutan from Oil Palm Expansion: An Economic Assessment. By Clem Tisdell and Hemanath Swarna Nantha, September, 2008.
152. The Orangutan-Oil Palm Conflict: Economic Constraints and Opportunities for Conservation by Hemanath Swarna Nantha and Clem Tisdell, October 2008.
153. Economics, Ecology and the Development and Use of GMOs: General Considerations and Biosafety Issues by Clem Tisdell, October 2008.
154. Agricultural Sustainability and the Introduction of Genetically Modified Organisms (GMOs) by Clem Tisdell, February, 2009.
155. Notes on Biodiversity Conservation, The Rate of Interest and Discounting by Clem Tisdell, April, 2009.
156. Is Posner's Principle of Justice an Adequate Basis for Environmental Law? by Clem Tisdell, June 2009.
157. The Sustainability of Cotton Production in China and Australia: Comparative Economic and Environmental Issues By Xufu Zhao and Clem Tisdell, June 2009.
158. The Precautionary Principle Revisited: Its Interpretations and their Conservation Consequences by Clem Tisdell, September, 2009.
159. The Production of Biofuels: Welfare and Environmental Consequence for Asia by Clem Tisdell, September, 2009.
160. Environmental Governance, Globalisation and Economic Performance by Clem Tisdell, November 2009.
161. Managing Forests for Sustainable Economic Development: Optimal Use and Conservation of Forests by Clem Tisdell, February 2010.
162. Comparative Costs and Conservation Policies for the Survival of the Orangutan and Other Species: Includes an Example by Clem Tisdell and Hemanath Swarna Nantha, May 2010.
163. Notes on the Economics of Control of Wildlife Pests by Clem Tisdell, May 2010
164. Are tourists rational? Destination decisions and other results from a survey of visitors to a North Queensland natural site – Jourama Falls by Clem Tisdell, June 2010.
165. Conservation Value by Clem Tisdell, June 2010.
166. The Influence of Public Attitudes on Policies for Conserving Reptiles by Clem Tisdell, July 2010.
167. Core Issues in the Economics of Biodiversity Conservation by Clem Tisdell, July 2010.
168. The Survival of a Forest-Dependent Species and the Economics of Intensity of Logging: A Note by Clem Tisdell, August 2010.
169. A Case Study of an NGOs Ecotourism Efforts: Findings Based on a Survey of Visitors to its Tropical Nature Reserve by Clem Tisdell, August, 2010.
170. Sharing Nature's Wealth through Wildlife Tourism: Its Economic, Sustainability and Conservation Benefits by Clem Tisdell, August, 2010

171. Economic Growth and Transition in Vietnam and China and its Consequences for their Agricultural Sectors: Policy and Agricultural Adjustment Issues by Clem Tisdell, September, 2010.
172. World Heritage Listing of Australian Natural Sites: Effects on Tourism, Economic Value and Conservation by Clem Tisdell, October, 2010.
173. Antarctic tourism: Environmental concerns and the importance of Antarctica's natural attractions for tourists by Clem Tisdell, October 2010.
174. Sustainable Development and Intergenerational Equity: Issues Relevant to India and Globally by Clem Tisdell, November 2010
175. Selective Logging and the Economics of Conserving Forest Wildlife Species e.g. Orangutans by Clem Tisdell, September 2011.
176. Economics, Ecology and GMOs: Sustainability, Precaution and Related Issues by Clem Tisdell, September 2011.
177. Economics of Controlling Vertebrate Wildlife: The Pest-Asset Dichotomy and Environmental Conflict by Clem Tisdell. September 2011
178. Ecotourism Experiences Promoting Conservation and Changing Economic Values: The Case of Mon Repos Turtles by Clem Tisdell, June 2012.
179. Sustainable Development Planning: Allowing for Future Generations, Time and Uncertainty by Clem Tisdell, June 2012.