www.eprawisdom.com e-ISSN : 2347 - 9671, p- ISSN : 2349 - 0187
EPRA International Journal of Economic and Business Review Vol - 4, Issue- 9, September 2016
Inno Space (SJIF) Impact Factor : 5.509(Morocco) ISI Impact Factor : 1.259 (Dubai, UAE)

NATURE AND SCOPE OF MARINE BIO-ECONOMICS

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ABSTRACT

The economic production can be achieved through biological resources and non-biological resources. The bioeconomics is the subject explaining the production of goods and services through biological resources and living resources. The subject marine bioeconomics is the branch of bioeconomics and it explains the production of goods and services through marine living organisms. This paper deals with content and meaning of bioeconomics. It outlines the concept of marine bioeconomics, structure of marine bioeconomics, bioeconomics of marine reserve and marine protected area and scope of studying marine bioeconomics. This paper concludes with some interesting findings along with policy suggestions.

KEYWORDS: *bioeconomics, marine, living resources, human enterprise*

INTRODUCTION

It is very essential to understand the content and meaning of Bioeconomics before discussing the nature and scope of marine bioeconomics. Bioeconomics is a progressive branch of social science that seeks to integrate the discipline of economics and biology for the sole purpose of creating theories a better job of explaining economic events using a biological basis and vice versa. Bioeconomics is the study of the dynamics of living resources using economic models. It is an attempt to apply the methods of environmental economics and ecological economics to empirical biology. Bioeconomics applies optimal control methods to mathematical models using environmental and ecological elements for resource protection issues relating to resource economics. Bioeconomics is the science determining the socioeconomic activity threshold for which a biological system can be effectively and efficiently protecting the life support system without destroying the conditions for its regeneration and therefore its sustainability.

The main area of interest is the investigation and clarification of the interactions that occur at the interface of the socioeconomic and biological system. They occur when the socioeconomic system in its daily activity impacts the biological system and gives rise to such phenomena as global warming, depletion of the ozone layer and others. It goes without saying that these interactive phenomena that are moreover complex and are of uncertain nature have serious repercussions for the human enterprise. The knowledge of bio economics is very essential to study such interactions.

LINK BETWEEN BIOLOGICAL SYSTEM AND ECONOMIC SYSTEM

The classical economic belief that the biological system is not a capital stock and that the biological resources are either infinite or are at best substitutable has done great damage to our thinking in relation to the planetary system and also in relation to our lifestyle as far as our methods of production and consumption are

concerned. Furthermore, it must be appreciated that humanity is an integral part of the biospheric system and its development and evolution must proceed in unison with that of the biological system; that is they have to coevolve.

The dynamics of the biological system is changing drastically due to the prevalent anthropocentric attitude which has to change to a biocentric one if the serve linear impact of the globalised economic system on the non-linear biospheric system is to be reversed now and to be avoided in the future. Moreover, the biocentric attitude is essential for the enhancement of the coevolution of the biological system with the human socio-economic system towards a harmonious and sustainable mode of existence. To achieve this sustainable existence the human socio-economic system will have to be transformed from a plundering capitalist system ignorant of the biological limits to economic growth and the intrinsic value of nature to a system whose activities will be adjusted to the socio-economic realities and more so to the biospheric realities of depletion of biological resources and severe environmental contamination.

According to Mohammadian (1980) bio economics is an innovative discipline developed with biocentric and coevolutionary perspectives in mind. It is a paradigmatic shift in the study of Economics by means of a thorough and complete synthesis between Biology and Economics to provide solutions for the uncertain and accumulative Bioeconomical problems facing humanity. Taking advantage of the vast accumulated knowledge of Biology and extending it to Economics would make available the necessary tools to tackle the complex an interactive problems present at the interface of the human biological and economic activity systems.

BIOECONOMICS: SYNTHESIS OF BIOLOGY AND ECONOMICS

In the past several decades new disciplines have been proposed to alleviate some gross weaknesses of the economic theory. Resource Economics developed Pearce and Turner (1990) was the first and has attempted to account for the scarcity of the biological resources and their true market value. As per the report by Pillet and Murota (1987) this has evolved to Environmental Economics taking into account what the economists have called 'externalities' that is the negative impacts of economic activity on the environment and which are outside the sphere of classical economic theory. According to Constanza (1989) ecological economics has been the most recent attempt in order to enlarge this field of study and to complete the missing links by studying the facts and relationships between the many aspects of the economy and the total environment in which it operates. The appearance of new problems such as the global warming and the depletion of the ozone layer has brought to light the theoretical defects of the classical and neo-classical economic theories in relation to the biosphere.

Bioeconomics is an attempt in this direction and pursues the symbiosis of economic activity with that of the biological activity in a coevolutionary manner for the mutual benefit of both. It makes possible a better understanding of not only the interrelations but more importantly the interactions between the economic variables and the biologic ones acting in the planetary system. Also, the discipline of Bioeconomics will be useful to clarify the systemic and evolutionary factors necessary for ensuring the sustainability of the planetary activities in its biotic and abiotic entity. In addition, it is quite possible that we will understand more fully how biological systems with such vast diversity have coevolved and continue to do so for the benefit of all. It should be obvious that this knowledge will be very useful for the coevolutionary development of the human economic system in a contaminated biosphere on the way to total depletion of its biological resources.

The economic rationality must interlock with the biological rationality thus adjusting the logic of the economic to the logic of the biologic. Certain market economic activities and modes of operation resemble that of biology and the Darwinian evolution through competition for survival, selection and adaptation allows to amplify the conceptual and theoretical foundation of Economics. But this should not lead to a new macroeconomic determinism dominated by "egoistic genes" of the economic agents that only wish to maximize profits and utility of their productive units i.e companies or that of the consuming units. However, it should be appreciated that cultural evolution is much more rapid than the biological evolution and humankind has the capacity to learn to face the challenges in order to coevolve towards biological and socio-economic systems of more complexity and maturity. Therefore, a new vision is needed now to put into context the human economic development and the development of all forms of life in general on a sustainable foundation thus avoiding the reductionist-mechanistic outlook and as such to renew the ethical principles and the value system in relation to nature.

The post-industrial globalised economic system should explore the biological organization a the foundation of the economic management and it should inscribe to the biosphere, because products of the biosphere cannot

be reduced to the market place however, all products of the market belong to the biosphere and are subject to biological laws". Likewise human beings must intervene in all economic activities as part and parcel of nature, means, agents and final objective and since these activities develop in a living environment which it impacts and interactions are produced, therefore the logic of the economic must be integrated into the logic of the biologic. The Bioeconomic paradigm attempts a drastic change in the investigation of these problems by studying the interactions in the economy-biology interface with an interdisciplinary, intersectorial and holistic methodology in order to confront the global problems in their dynamics of actions, reactions and interactions between the realm of economy and the realm of biology.

BIOECONOMIC DEVELOPMENT AND COEVOLUTION

Bioeconomics is a synthetic and interdisciplinary methodology that makes it possible to investigate the interactions that present themselves at the biology-economy interface. These interactions will also have to be studied both at the temporal as well as spatial scale in a holistic and integrated manner. In this way, it is hoped to develop a Bioeconomic model with scientific rigour to be useful as a model for coevolutionary development.

Coevolution is a dynamic process that functions as a series of reciprocal responses between two interactive and evolving systems. The human economic system is totally dependent upon the biological system and both are very interactive. The human species, contrary to other animal species, not only uses but also constructs and transforms its natural environment that as a result is in a constant process of change; that is to say that nature is transformed and is re-created.

Although interactions between the human economic system and the biological system have been generally positive and productive it is also true that in many cases they have been unfavourable and have resulted in coevolutionary cases that have been very damaging for the planetary system. A very outstanding example is the case of human ignorance of the danger sings emanating from the impact of human economic activity associated with the global warming, the depletion of the ozone layer and others. Also, there have resulted from this unfavourable coevolution national and regional conflicts with grave consequences or the biospheric system. These conflicts, all of them resulting from unfavourable coevolutionary interactions, have their origin in the human psyche and therefore, it is essential to affect a drastic transformation to change to a more biocentric attitude and a less anthropocentric one.

However, it is also true that the direct causes of these conflicts are to be found in the over-exploitation of the biological system by the socio-economic system of competition, production and consumption that is forever more complex technologically and as a result loses its capacity for profiting from the potential of development generated by the coevolutionary process. To take the first steps toward a sustainable society to be founded on conservation and coevolution it is necessary to appreciate the errors of our culture based on the supremacy of humankind and its commercial inclination for wastefulness and abuse of biological resources. There must be something drastically wrong with a culture that in the name of improving the quality of life is finishing with its own biological capital, contaminating its own 'home' and thus endangering its own survival.

Consequently, Bioeconomics with its inherent coevolutionary perspective founded upon the cultural and traditional knowledge of bioeconomic systems evolved during millenniums can facilitate a model of coevolutionary development with optimum management of human and biological resources. In other words, Bioeconomics is the scientific discipline and the coevolutionary process is a functional tool available to put the theory of Bioeconomics at the service of coevolutionary development.

BIOECONOMIC MODEL

According to the Bioeconomic development model the perfect substitution of different forms of capital cannot be taken for granted. Some biological goods and services viz biogeochemical cycles are essential for the maintenance of life support systems and cannot be replaced. However, there exist some biological assets that although they could be considered not essential for the human well-being nevertheless they are essential for human survival or for that of other species. According to Pearce and Turner (1990) these 'vital' assets such as the atmosphere, the ozone layer and others could be classified in a sub-division under "critical natural capital" and are practically not substitutable.

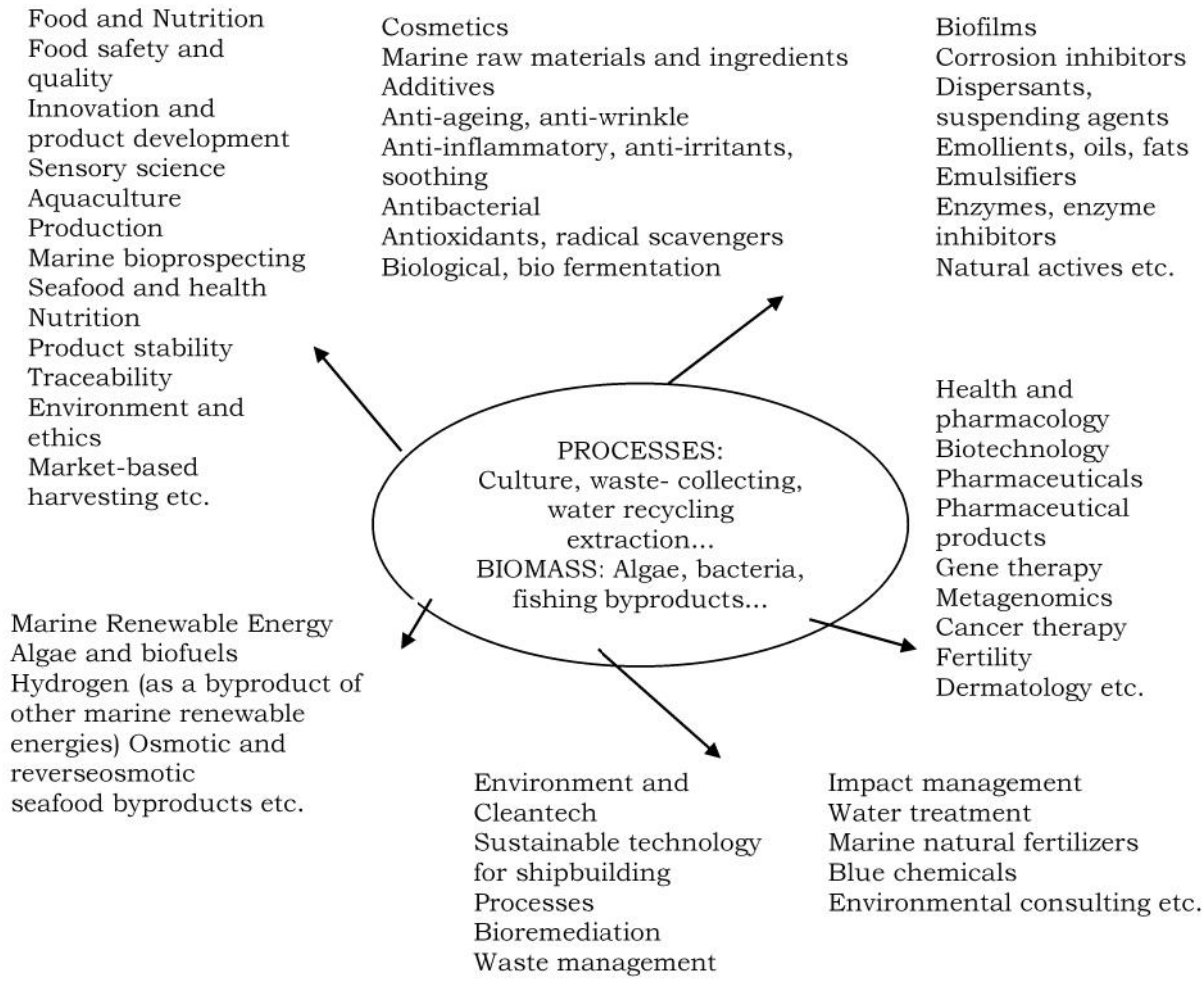
The Bioeconomic model also emphasizes the value of the biological system in response to humanity's performance and the fact that it enjoys an intrinsic value necessary for its vital functions which exceed individual desires or even that of human existence or the existence rights of other species. These are all integral parts of the Bioeconomic model of human sustainable development and should take precedent over market regulatory mechanisms optimizing the process of economic development. According to Maturana (1970) biological theory of cognition and the system concept a human being

as a living system is a cognitive system and the process of life is a cognitive process. Maturana and Varela (1987) note that a living system responds to its environment by continuous changes which transform its reactions and behaviour through cognition by means of "structural coupling". The significance of this for human sustainable development should be obvious as it is quite possible that the economic activity by structurally coupling with the biological activity, that is by means of continuous interactions and structural changes, becomes a quasi-cognitive system in the form a Bioeconomic system and therefore the human economic development process is rendered more efficient in its production and less entropic in the utilization of biological resources, in short, more sustainable.

MARINE BIOECONOMICS

Marine bioeconomics is the branch of bioeconomics that seeks to integrate the disciplines of economics and marine biology for the sole purpose of creating theories and practical knowledge towards explaining economic events using a biological basis and the vice versa. Marine life is a vast resource, providing food, medicine, and raw materials, in addition to helping to support recreation and tourism all over the world. At a fundamental level, marine life helps determine the very nature of our planet. Marine organisms contribute significantly to the oxygen cycle, and are involved in the regulation of the Earth's climate. Shorelines are in part shaped and protected by marine life, and some marine organisms even help create new land. Marine biology covers a great deal, from the microscopic, including most zooplankton and phytoplankton to the huge cetaceans (whales) which reach up to a reported 30 meters (98 feet) in length.

Structure of Marine Bio Economy



The habitats studied by marine science include everything from the tiny layers of surface water in which organisms and abiotic items may be trapped in surface tension between the ocean and atmosphere, to the depths of the oceanic trenches, sometimes 10,000 meters or more beneath the surface of the ocean. It studies habitats such as coral reefs, kelp forests, tide pools, muddy, sandy and rocky bottoms, and the open ocean (pelagic) zone, where solid objects are rare and the surface of the water is the only visible boundary.

Many species are economically important to humans, including food fish. It is also becoming understood that the well-being of marine organisms and other organisms are linked in very fundamental ways. The human body of knowledge regarding the relationship between life in the sea and important cycles is rapidly growing, with new discoveries being made nearly every day. These cycles include those of matter such as the carbon cycle and of air such as Earth's respiration, and movement of energy through ecosystems including the ocean. Large areas beneath the ocean surface still remain effectively unexplored.

Marine bioeconomic is the discipline that combines concepts about the biological productivity of a resource and the economics of commercial fishing. The bioeconomics of living renewable resources is the essence of fisheries science, distinct from simply the biology or the population dynamics of marine resources. Most marine species have complex and diverse habitat requirements at different stages of their early life history. These are often very different to the needs of the adult stock.

- All marine species interact via a complex food web, from primary producers to top predators. This web cannot be fully quantified or understood, but fisheries management cannot completely ignore it, because it implies that fishing may lead to undesirable ecological consequences.
- The mortality of commercially exploited species can be ascribed either to natural causes or to fishing. When natural mortality is high, then fishing mortality should also be high to compete effectively with natural predators. Conversely, resources with a low natural mortality are best harvested with a low fishing mortality.
- Most marine resources are selected with large number of offspring with high natural mortality and can withstand adverse environmental conditions, and a substantial fishing mortality, without going extinct.

Marine Bioeconomics involves the rational and quantitative trade-off of biological risk against economic return with the overall aim of ensuring profitability for the fishery and other marine living organisms without compromising the long term productivity of the resource. An important result that flows from bioeconomics is that managing stocks so that they produce marine sustainable yield is not necessarily the most sensible approach from an economic point of view. Marine resources are inherently very variable. This variability affects catches, and is due to a combination of factors. One of these is the high degree of variability in the size of the recruitment and natural mortality streams, which causes fluctuations in the resource biomass, and hence catches. Other factors which affect catches are variability in the behaviour of fish, which might move from one place to another, with the result that their availability to the fishing gear at a particular place and time may vary. Even if they are available at the right time, they may not respond to bait or other gear in the expected way.

Marine Bioeconomics may refer to: bioeconomics (fisheries), the study of the dynamics of living resources using economic models. Bioeconomics, is closely related to the early development of theories in fisheries economics, initially in the mid 1950s by Canadian, biophysical economics. The study of the dynamics of living resources using economic models, bioeconomics (fisheries) thermoeconomics, also, econsimp is a bioeconomic management model of the barents sea fisheries. The gordon-schaefer model is the center of bioeconomics. It is one of the driving models behind attempts to compute the maximum and minimal bioeconomic program.

BIOECONOMICS OF MARINE RESERVE AND MARINE PROTECTED AREA

Marine ecosystem valuation and the analysis of global issues such as fisheries subsidies are the subject matter of marine bio economics. Marine Bio-economics is the study of biological and economic relationships of marine living organisms. In the context of marine protected areas, it is a modeling discipline that offers insights to: the costs to commercial fishermen in terms of closing off areas from harvesting; the economic value of subsequent increases in catch rates in areas adjacent to the protected areas in terms of the 'spillover' effect; the behaviour of fishermen following a marine closure and the effect of this spatial redistribution of fishing effort on economic benefits; and the beneficial effect of marine reserves to commercial fisheries as a buffer or hedge

against uncertain environmental shocks. Bioeconomic modeling does not appear to have kept pace with the burgeoning policy interest in marine protected areas. While there is now a vast international literature on the ecological benefits of marine protected areas, less has been done to integrate economics with the biology. But with increasing sophistication of bioeconomic modeling, marine bio economists are beginning to change their views on the value of marine protected areas as a fisheries management tool. Theoretical modeling has shown that due to the 'buffering effect' provided by marine reserves against environmental shocks and other forms of uncertainty, marine reserves can increase the cumulative harvest and

generate positive economic payoffs even if harvesting is optimal and the fishery is not overexploited. Moreover, these benefits cannot be obtained from either input or output controls. The economics of marine protection is inextricably linked to the ecology of marine environments. A solid understanding of marine biology and the behaviour of fish stocks is therefore required to build a picture of the likely economic consequences of policy interventions such as the establishment of marine protected areas. Thus the marine bioeconomics is the study of biological and economic relationships.

It is common for marine bioeconomic models, or representations of reality, to be developed for the purpose of managing commercial fisheries. In these studies, physical information on the characteristics of fish populations, and the responsiveness of fish populations to human interventions such as harvesting and habitat modification, is used to estimate the economic impacts of different levels of harvesting. Economic measures include catch per unit effort, value of harvest, economic rent and employment.

The value of marine bioeconomic modeling is to assist with understanding complex systems that cannot be easily conceptualized in a single dimension. When many variables interact to produce an outcome, it is often difficult to know the net effect of a change to the system in advance of connecting all the individual components of the system. Models can therefore be used as a tool for making more informed decisions.

In order to regulate the utilization of marine resources, the following marine bio economic activities are required. Fishers are not the only participants in the fishing sector, and their wage expectations cannot validly be pegged to the value of the end product, since this ignores downstream costs and wage earners. Fishers and other members of coastal communities have the right to benefit from the exploitation of marine resources. Their participation in the fishery could take many forms entrenched fishing rights, quota, corporate share holdings and wages which will give them economic and social security in proportion to the value of the fishery in their region. At the same time social considerations should not be allowed to override basic bioeconomic principles in fisheries management. In most cases it is undesirable to increase fishing capacity for the development of new resources new species and new habitats. A much more responsible approach should be to divert effort and capital from overexploited resources to new fisheries, thereby giving "old resources" time to recover without suffering an overall unacceptable socioeconomic loss. This option is of course not always feasible because different fisheries may sometimes require the deployment of completely new and different technology.

Bioeconomic models of marine reserves need to consider a number of key processes: the transfer rate and flows between reserves and harvested areas, the effect of reserves on fisher behavior and the influence of environmental stochasticity and shocks on both the reserve and fished population Reserves can generate a range of potential ecological benefits, some of which may generate spillovers in harvested areas that result in economic benefits. Thus the existence of ecological benefits of reserves is necessary, but not sufficient to ensure positive economic benefits from harvesting. The ecological benefits of reserves arise from reduced mortality and decreased habitat or environmental damage due to the establishment of no-take areas. Improved habitat quality for targeted species due to a reserve is most evident if particular fishing practices, such as bottom trawling, are prohibitions.

SCOPE OF MARINE BIOECONOMICS

Marine and coastal ecosystem services valuation and management, as well as bio-economic and econometric modelling, is used to support analyses of marine spatial planning and investigating natural capital trade-offs between environmental conservation and blue growth. The Knowledge of Marine Bioeconomics enables one to make assessment, quantification and valuation of marine and coastal ecosystem services, assessment of management options using tools including cost-benefit analysis, multi criterial evaluation and driver pressure-state-impact-response framework, analysis and evaluation of marine spatial planning options and impacts, socio-economic data collection tools such as social surveys and stated preference surveys, local and regional economic and econometric analysis, marine climate change risk assessment on the environment, fisheries, and aquaculture

and marine and coastal natural resource economics capability building.

Marine Bioeconomics deals with issues related to the valuation and management of coastal blue carbon vegetated ecosystems such as salt marshes, sea grasses and mangroves which provide several ecosystem services including sequester and store CO2 from the atmosphere, coastal protection, and fish nursery grounds and the economic implications of blooms of non-native invasive species.

The study of marine bioeconomics enables one to understand the marine reserve and potential benefits of marine reserves. This subject knowledge helps to understand the marine bio resource structure in terms of uncertainty through stochastic models, implications for fisheries management, biocontrol of fouling organisms, marine microbes including plankton and living on the edge an insight into extraterrestrial life. Bio economics of coastal estuaries, classifying ecosystem goods and services provided by estuaries and future research needs are brought under the subject marine bioeconomics.

The subject knowledge on marine bioeconomics enables one to understand the marine primary production. In this context, one can understand the overview of marine primary production, gross primary production and net primary production, oceanic production, measurement of primary production, marine productivity and resources for photosynthesis. The knowledge of marine bioeconomics enables one to study the marine biodiversity hotspots. In this context, one can define the biodiversity hotspots. This subject makes an assessments of global marine hotspot', regional and local hotspots, biologically mediated habitat, continental shelf, open oceans and resistance to changes in abiotic and biotic factors. The marine primary production explains the adaptation and the consequences of mortality at different trophic levels, adaptation assisted by man, raw materials, including ornamental resources, rocky shores, problems and adaptations, sandy shores, arctic vs antarctic, estuaries, biodiversity of estuarine ecosystems, salt marshes and functioning and adaptations.

The marine bioeconomics deals with marine biodiversity valuation. It enables one to understand the meaning of marine biodiversity valuation, potential application of the concept of marine biological valuation, biological valuation maps, cultural values, socio-cultural valuation, application of the criterion in valuing the marine bio resources, marine decision support systems, marine ecosystem as a source of economic value and goods and services provided by marine ecosystems and nutrient cycling value.

The marine bioeconomics subject knowledge enables one to understand the threats to marine biodiversity. Bioeconomic analysis facilitates to generate knowledge on over exploitation of marine resources, overexploitation effects, measures on conservation of marine resource, marine reserves and marine protected areas and threats to the coastal zone. The knowledge on land use and human populations impact on coastal industries and constructions, dredging and dumping at sea are brought into discussion in marine bioeconomics subject. Marine bioeconomics promotes knowledge on marine biodiversity changes, impacts of biodiversity change on ecosystem stability, combined effect of species loss and disturbances, effects of climate change on phytoplankton and harmful phytoplankton blooms, global change

Marine bioeconomics deals with marine biodiversity research. In this context, one can understand the biodiversity measurement techniques relating to non-parametric indices, taxonomic indices, functional diversity, species abundance distributions, species-abundance models, sampling, types of sampling studies, sampling tools for the marine environment, sampling tools for pelagic organisms and sampling tools for benthic organisms, microbial research.

The knowledge of bioeconomics promotes on understanding on invertebrate marine bio resources. This subject deals with economic and commercial importance of marine invertebrates species particularly shrimp culture, lobster culture, crab culture, sea weed farming, mussel culture pearl oyster culture and marine algae culture. This subject enables one to understand the sea cucumbers, jelly fish, sponges, chino bacteria and other marine invertebrates.

Through marine bioeconomics one can understand the economic and commercial importance of marine vertebrates. This subject imparts knowledge on economic and commercial importance of marine fish species, effects of overfishing, economic importance of sea turtle, threats to sea turtles, marine mammal, diversity, distribution and habitat, threats to marine mammals in aquatic ecosystems and endangered marine mammals list.

Through this subject one can know bio economics of coral reefs. In this context, the knowledge of goods and services of coral reefs, threats to coral reefs, coral mining, economic value of coral reefs, costs and benefits of coral mining, economic analysis of coral production: societal costs of coral mining, climate change and bleaching of corals, ecological and socio-economic significance of coral mortality, coral restoration objectives and techniques and coral restoration costs, case studies. Further the knowledge

of coral restoration benefits, decision-making for coral restoration and assessing restoration costs and benefits over time through marine bioeconomics.

The knowledge on bioeconomics of seaweed farming is very essential. In this context, the knowledge relating to seaweed culture and economic importance of seaweed food, problems and prospects of sea weed farming, seaweed cultivation practices and utilization, commercial cultivation and processing of sea weed and research and development in sea weed farming can be understood through marine bioeconomics.

The knowledge of bioeconomics is very important to understand the seafood demand and marketing. Through this subject the knowledge can be generated to understand the nature of sea food, health benefits of sea food, seafood quality, importance of seafood consumption of seafood, production and consumption trends, marketing of seafood. Further marine bioeconomics promotes the knowledge on marketing management in aquaculture, fish marketing structure, marketing channels, analysis of marketing costs and marketing margin, marketing functions, investment and earnings by different players in the chain, quality assurance in domestic marine product marketing, international sea food trade and sustainability issues and impact of subsidies on fish trade and sustainability.

The knowledge on fisheries bioeconomics is very important aspects of marine bioeconomics. In this context, the knowledge on fish stock assessment and fishery management, biological fisheries models, fisheries economic analysis, socio-economic evaluation and impact studies and status of women in fisheries. This subject imparts knowledge on current programmes and thrust areas of research in fisheries economics, production function and economic efficiency in fisheries management andeconomic tools for evaluating fish business. Further the knowledge on bioeconomic fisheries models and marine fish marketing in India are learnt through marine bioeconomics.

It is very essential to study the mariculture through the devices of marine bioeconomics. Bioeconomics of mariculture enables one to understand the economic analysis of cage culture of sea bass, economics of shrimp farming, cost and earnings of open sea mussel farming, and economic analysis of land-based production of cultured marine pearls in India. Further mariculture knowledge is very essential to understand the natural pearl fishery, pearl oyster resources and pearl culture in India, prospects for marine pearl culture in India, pearl culture and rural development, edible oyster culture, main considerations in oyster culture, lobster farming, farming potential of spiny lobsters, farming technologies and environmental and social issues in coastal aquaculture and environmental impact through the subject matter marine bioconomics.

The study of marine bioeconomics enables one to understand the mariculture projects with respect to farming technology of green mussel, technology of mussel culture, mud crab fattening, shrimp farming, edible oyster culture and ornamental fish breeding. The development of sea farming in India can be understood through marine bioeconomics. This subject enables one to understand the status of coastal aquaculture, aquaculture diversification programmes, major constraints, diversification of coastal aquaculture, culture methods, growth patterns, seed production, harvesting and marketing, economics and management measures and prospects of sea farming in India.

The subject economics of marine protected areas can be learnt through marine bioeconomics. In this context, the knowledge on economics of marine protected area in terms of framework for consolidating the benefits and costs, benefit-cost and distributional issues, marine conservation incentives, coral reefs conservation issues, marine conservation technology, positive and negative incentives towards conservation of marine protected area and benefits and enforcement, performance monitoring and benefit packages can be learnt through marine bioeconomics. The knowledge on marine mussel bio economics is very important towards understanding the potential effects of marine mussel farms, effects of marine farms on marine ecology, mussel culture, mussel production in culture system and economics of mussel culture.

The economic aspect of marine turtle use and conservation comes under the bioeconomic subject. In this context, the knowledge on distribution of turtles, framework on consumptive marine turtle use, non-consumptive marine turtle use, direct use options: economic consequences of a fundamental policy decision, direct use, passive use, cost of marine turtle loss and conservation measures can be imparted through the subject matter marine bioeconomics.

The subject knowledge on marine mammal conservation is a part of marine bioeconomics with respect to impediments to conservation of marine mammals, refining the concept of marine mammal status, major threats to marine mammals, guiding principles for addressing threats, vision and crisis avoidance and a new conservation paradigm. The impact of marine pollution on marine living organisms can be understood through

marine bioeconomics. The knowledge on pathways of pollution, direct discharge, atmospheric pollution, deep sea mining and noise pollution on marine living organisms can be known through marine bioeconomics.

The status of Indian marine and coastal environment can be learnt through marine bioeconomics. Through this subject one can learn marine environmental protection, sustainable development of small islands, marine environmental protection, concerns, towards a healthier marine environment.

CONCLUSION

It could be seen clearly from the above discussion that the knowledge of bioeconomics is very essential in general and knowledge of marine bioeconomics in particular. It is significant to note that utilization of biological resources in production of goods and services can prevent the environmental degradation, global warming, ozone layer depletion and pollution. It is possible by the way of reducing the release of pollutants and green house gases. The promotion of knowledge on marine bioeconomics is very essential towards proper utilization and sustainable utilization of marine bio resources towards production of goods and services.

In order to promote the knowledge on marine bioeconomics, the following suggestion can be considered.

1. The government should allocate more funds for research on marine bioeconomics and publishing its results.
2. The government should motivate the researcher towards identifying the marine bio resource potential, exploitation level and conservation measures through geographical information system and through remote sensing technique
3. The government should promote inter disciplinary and multi disciplinary research to assess the marine bio resource potential, marketing and consumption by the way of developing research team consisting of economists and marine scientists along with provision of research infrastructural facilities.
4. The government should give liberal research grants and subsidies towards promoting research on innovative maricultural practices and propagating the research outputs to the fisher man households
5. The government should motivate the private institutions and NGOs towards conducting the research on developing maricultural practices in the coastal villages
6. The government should encourage the researcher towards developing seaweed farming in and around the coastal area
7. The government should promote research on developing marine bioeconomic modeling focusing on protection of marine reserves and marine protected areas.

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