*Chapter 1*

# INTRODUCTION

The relationship between economic growth and the environment is always a controversial subject. Many researchers have brought it into the light and everyone has different opinions about this matter. However, most of the recent research pointed out that economic development has negative impacts on the biophysical environment. A country like India, which is in its developing stage, has numerous urgent requirements and objectives. The uses of resources here are subjected to competition and sometimes can be mutually conflicting. The main objective of such developing countries is to enhance economic conditions through improvement in employment in industrial and agricultural sectors, earnings from foreign exchange, creating better living standards and national development. However, the need to maintain sustainable environmental conditions as well as natural resources conservation cannot be denied.

Since the last three decades, export of aquaculture products, specially shrimp has become a major source of foreign currency for many countries throughout the globe, especially those having vast coastal area. Shrimp culture has been recognized for aiding economic growth of these countries. Presently, India is well recognized as one of the leading exporters of coastal aquaculture productions, where shrimp is the most important one. The Tiger shrimp (*Penaeus monodon*) and Vannamei shrimp (*Litopenaeus vannamei*) bring a remarkable benefit to the aquaculture of coastal areas. Shrimp farming has increased in India at an unprecedented rate in the last three decades. With the availability of unproductive coastal land, innovation and development in hatchery technology, increased demand for exports and opening the economy in the 1990s led to the abrupt growth of intensive commercial shrimp farming. Shrimp production in India has increased from 1,02,940 metric tons (MT) in 2001-2002 to 4,87,470 metric tons in 2015-2016 (MPEDA, 2017). The success of shrimp culture and the profit margin have encouraged more financer to invest into this business. By adopting scientific technology private entrepreneurs have made this business stronger and more financially sound.

Irrespective of the negative environmental effects of shrimp culture, it plays a major role in the rural development and the economic development of the coastal villages.

There is a great contribution of shrimp culture to the national earrings from exports to many South East Asian countries, Japan and USA. In the year of 2016-17, the total export of shrimp was pegged at 4,34,484 MT, with worth of USD 3,726.36 million. Export of shrimp of our country has increased by 16.21 % in quantity and 20.33 % (in USD) terms (MPEDA, 2017). The economic contribution and the present status of the shrimp culture directly indicate to the brackish water resource availability in India which is suitable for the culture of shrimps.

In the economic development, the shrimp culture has definitely contributed positively however, its impact on environments like soil and water pollution, damage to natural resources and depletion of natural habitats cannot be denied. Unfortunate but the truth is that the development of shrimp farming in India is the result of the destruction of natural resources such as the deforestation of trees and aquatic living organism in the coastal area. The speedy development of shrimp farming is always questionable and demands a strong focus towards environmental factors as well as socio-economic criteria. Shrimp farming may have immediate and direct impacts that give rise to secondary and indirect impact later. The direct and indirect impacts may sometimes correlate with a short run and long run impacts. The farm construction and its operational state may lead to permanent change in the nature of the land. The impacts also have a spatial dimension and mostly, the environmental resources are non-renewable hence, once destroyed, may be lost forever. Such losses may become more severe in future and must be evaluated properly. Some of these impacts can be quantified while others are less tangible. Although it is desired to get some general benefits from a particular project, most of the time it is seen that some groups or areas have undergone huge adverse effect, which are mostly neglected to account only the financial benefit. Subjective perception of the impacts may significantly influence the responses and decision of humans towards the desired development (Glasson et al., 1999)

In general, Environmental Impact Study (EIS) is carried out by using different assessment tools to investigate all the impacts and finally makes a decision at the advanced stage of a large scale project; whereas small scale projects are started without prior environmental assessment. A proper methodology is to be followed to analyse the consequences of environmental conditions and the decision is made accordingly

following some international standards (Elkin et al., 1988; Lee and Colley, 1992). At present, traditional techniques are used for the purposes, which lack in systematic approach, without focusing on its multidisciplinary character and holistic manner required to get the detail environmental impacts. EIS is an advanced tool which is capable of assessing numerous multidisciplinary parameters that affect the environments at various stages of the project. The process involves a number of steps which are briefly described below.

- **Activity screening** narrows the application of EIS to those activities which have significant environmental impacts. It is one of the most important steps of environmental impacts assessment.

- **Scoping wants to identify** the crucial and significant issues at the initial stage, from all the possible impacts and options that can be solved. Checklist method is very popular in the identification of prime impacts.

- **The details of the farm development study** include an explanation of the purpose and rationality of the farm, and an understanding of various features, including steps for development, location and process.

- **The establishment of the present and future state of the environment** is always a considerable factor while describing the environmental baseline. All the factors are accepted considering that there are no farming activities at that time. Also it is desired that natural events and some human activities have caused these changes.

- **The evaluation and assessment of relative significance and magnitude** can be done with 'Leopold Matrix', proposed by Leopold et al. in 1971 is a noteworthy method used for the process. Techno-economic evaluations are sometimes done to appraise all the positive and negative impacts.

- **The focus of mitigation** is to introduce a significant measure to investigate various adverse impacts, finding the preventive measures and proper remedies. In this technique, emphasis is given on proper planning and sustainable use of natural resources.

- **The aim of involving public in discussions and consultations** is to assure the quality, comprehensiveness and effectiveness of the Environmental Impact

Study and that the public views are adequately valued for all the considerable processes.

Environmental Impact Study (EIS) is always a circular sequential action. Feedback is very vital in cyclic activities like EIS and interaction between different steps also plays important role.

Brundtland Commission has accepted the principle of ecologically sustainable development, which defined it as one that 'meets the needs of the present, without compromising the ability of future generation to meet with their own needs' (WCED, 1987). The objectives of sustainable development are accepted by Food and Agriculture Organization (FAO) and it is defined as 'the management and conservation of natural resource base, the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations'. This sustainable development is followed by all positive consequences which helps in land conservation, water resource conservation and maintenance. This is also very beneficial for the animal and plants, and would lead to production by environmental friendly, economically viable and socially acceptable technologies (FAO, 1995). There is an acute need to accelerate the sustainable development of shrimp culture, with minimum adverse impact on environment. For the scientific and sustainable development of shrimp culture, site selection plays an important role which is always followed by an improved culture management. Proper planning and monitoring are required for the sustainable use of land as well as the improvement of the environmental and socio-economic condition of the region.

To create a balance in the aquatic ecosystem it is highly required to maintain the natural coverage areas with the focus on the changes and consequences. Proper management and utilization science and technology contribute to sustainable shrimp farming with maintenance of required eco-balance, specially the land cover.

For the quantitative measurement in the changes of land cover at the landscape level, Remote Sensing (RS) is considered to be the most useful data acquisition system (Hudak and Wessman, 1998). The present Land use and Land cover (LU and LC) pattern is directly linked to the human activities. The magnitudes of these activities vary depending on the locations without following any pattern. RS technique is well suited

for multi-temporal investigation, disclosing the changes in LU and LC dynamics and to provide necessary information on LU and LC (Singh, 1989).

The main parameters that are important in assessing the environmental impact are the soil and water characteristics. There are numerous factors involved in the occurrence of soil and water problems. These factors contribute to the degradation of land resources and also cause the declination in the crop yields. The salinity in the soil is one of the oldest issues for mankind that has affected agriculture production. It is a major factor that has turned high-quality lands into low quality ones. For monitoring the quality of water, an advanced approach is obtained by the integration of RS and GIS techniques. A cost-effective and quality research solution is brought up by utilizing RS and GIS approach. The identification of aquaculture suitable site selection is done in many different ways in the past. Mostly it is done by accessing the conditions of local sites. But these processes are not capable of doing the site assessment synoptically and temporally.

Apart from the issues of the landholding pattern, the lacking of synoptic vision in traditional modes of research and the use of incomprehensive methods of estimation, location mapping are mostly done inadequately. Data help in building the structural model but characterization of the intensity and diversity of LU and LC are required. It is important to link time-dimensional LU and LC data to the sustainable situation. Because of systematic data acquisition and high-level precision RS and GIS are ideally suited to identify potential sites for shrimp culture (Kapetsky et al., 1989; Nath et al., 2000; Rajitha et al., 2010).

The coastal block of Purba Medinipur district, which is considered as one of the 'hot spots' in the view of shrimp culture development in India, was selected for the present investigation. The results of the various studies conducted in India show an uncontrolled and unplanned growth of shrimp farms. (Proulx et al., 1996; Tong et al., 2004; Giap et al., 2005). Considering the issues of shrimp culture expansion, the study site is selected as a representative aquatic region in which strategies for socio-economic and environmental impact analyses and sustainable development of shrimp culture must be implemented.

## 1.1     Research questions

Is the coastal shrimp farming actually experiencing sustainable development or just on the basis of profit margin or economic growth we are appreciating illegal shrimp farming on the coastal areas of West Bengal? Is the concept of sustainable aquaculture only a theory or does it actually exist in practice too?

## 1.2    Aim

The aim of the present study is to identify environmental and socio-economic impacts of shrimp farming on coastal blocks of the Purba Medinipur district, West Bengal through collection and assessment of the informative data. The fruitful investigation is likely to contribute towards the sustainable development of this area.

## 1.3    Objectives

In the view of the above background, the specific objectives of the research are as follows:

1. To generate a micro level spatial database on inland waterbodies of coastal blocks of Purba Medinipur District, West Bengal to develop aquaculture/fisheries information system by using Remote Sensing and Geographic Information System.
2. To identify, quantify and predict the Land use and Land cover changes with a special focus on shrimp culture development.
3. To point out the socio-economic as well as environmental impacts of shrimp farming area.
4.  To identify and prioritize the potential sites for sustainable shrimp culture using Remote Sensing and GIS techniques.

## 1.4  The scope of the study

Restricted by the subjective and location-based extent of this research, the scope of this study can be discussed through the following points.

- Developing a GIS database of micro-level Land use and Land cover information, and optimum Land use and Land cover categories.

- Comparative analyses between the past and the present Land use and Land cover pattern with a focus on coastal aquaculture development. The result of land use and Land cover change detection made it very convenient to the fisheries sector to collect proper data with ease regarding the spatial distribution.

- Identification of environmental and socio-economic impact of the region through the analysis of available data and public feedback.

- Suitable site selection for shrimp culture through the multi-criteria decision evaluation (MCDE) is required to achieve sustainable coastal aquaculture by eliminating environmental as well as social constraints. With the development of sustainable shrimp culture, economic standard of the coastal communities should be improved.

- The methodology formulated in this study for the identification and prioritization of potential sites for shrimp culture may be applicable to other areas with similar development activities.

## 1.5    Limitations

Every research work has its own limitations and this is not an exception.

1. High-resolution satellite data are extremely expensive and hence in this study, Google Earth is considered as the reference. But from Google Earth, it is not possible to collect data continuously in some particular interval of time.

2. The plot-level study is a time-taking process, and for this one selective mouza is considered to do this study.

3. Due to the unavailability of modern instruments only two parameters (pH and salinity) are taken into consideration for this study.

4. Non-availability of reliable secondary data has badly affected the accuracy of socio-economic impact evaluation. This data is not reliable because it is based on the primary survey of other scholars and their reviews.

In spite of all limitations, it can be considered that this research is accomplished equipped with a higher level of scientific and contemporary techniques, and with reliable satellite data products. Hence, it is a unique study that is made first time in the region and pointing the way of sustainable development based on advanced

technological know-how. The study considers maintenance of equilibrium between the needs of human and economic developments within the parameters of environmental conservation through the efficient use of natural resources.

## 1.6    Organization of the thesis

The thesis consists of nine chapters that describe all the major components of the present investigation. In Chapter 1 problem statement is defined with the aim and objectives of the study. The major reviews on shrimp culture development and their related issues and sustainable development of shrimp culture, emphasizing the Indian scenario are discussed in Chapter 2. The potential of Remote Sensing and GIS for sustainable development of shrimp culture are also presented with case studies. An overview of the study area for the present investigation is presented in Chapter 3. All the data and methodologies used for the completion of this research work are discussed in Chapter 4. Chapter 5, 6, 7 are organized focusing on the objectives of the research. Chapter 5 is dedicated to the land use and Land cover change detection and prediction whereas Chapter 6 is an elaborated description of environmental impact assessment and prediction.  Potential site selection for shrimp farming is one of the most important factors towards sustainable development and is involved descriptively in Chapter 7. The major findings from Chapter 5, 6 and 7 have been discussed in discussion chapter of Chapter 8. The summary and conclusions of the research and avenues for future research are discussed in Chapter 9.