Chapter - IV

Legal and Illegal Sand Mining activity over Kollidam River bed:
A People’s Participatory Approach

4.1 Introduction

As essential industries in today’s environmentally aware society, it is vital that quarrying, mining and dredging operations ensure that they achieve the best possible environmental management of their activities. Poor environmental management within the industry results not only in non compliance of legislation, which includes heavy fines, but also in poor public relations, loss of business, and loss and destruction of wildlife and habitats. Good environmental management in the industry can result in good publicity and public relations, increase in business, and the creation of habitats for a variety species, including endangered species and specialist habitats.

Understanding the essential role of the extractive industry and its contribution to society is an important part of the education process. It is equally important to recognize and increase understanding of the industries environmental impacts, both negative and positive, and understand management techniques to both mitigate in the former and enhance in the latter. India recognizes that mining, unless properly regulated, can have adverse environmental and social consequences. It seems that the illegal miners are omnipotent, omnipresent and omniscient, as the government the supposed to beal mighty is on their side. The reports on illegal mining across the states and its adverse environmental impact deserve a place in newspapers daily almost. Illegal sand excavation by mafias across major river basins, sand was mined in order to cater to the construction need of the local villages and government offices. Since the rivers had sand all over their pathways, ground water table all
along their winding routes was kept intact. Due to the over exploitation of river sand, the watercourse has become lower than the level of irrigation canals and hence, the irrigation canals get water only when the river is flooded. As a result, the local tanks that depend upon the river for water remain dried all through the years, except the years that have heavy downpour. Thus, over exploitation of river sand results in the destruction of agricultural practices, across the districts and state.

Sand is an important mineral for our society in protecting the environment, buffer against strong tidal waves and storm, habitat for crustacean species and marine organisms, used for making concrete, filling roads, building sites, brick making, making glass, sandpapers, reclamations, and in our tourism industry in beach attractions. Sand mining is the process of removal of sand and gravel where this practice is becoming an environmental issue as the demand for sand increases in industry and construction. In almost every mineral bearing region, soil mining and land degradation have been inseparably connected. Unscientific mining has caused degradation of land, accompanied by subsidence and consequential mine fires and disturbance of the water table leading to topographic disorder, severe ecological imbalance and damage to land use patterns in and around mining regions (Ghose, 1989).

Mining is a major contributor (2'nd) to the national GDP (4 Per cent) occupying 36 lakh ha. (0.11 Per cent) of total land area (329 m ha) and providing employment generation (4 Per cent) for 1.1 million people of the country. In almost every mineral bearing region, soil mining and land degradation have been inseparably connected. India recognizes that mining, unless properly regulated, can have adverse environmental and social consequences. Mining is essentially a destructive development activity where ecology suffers at the altar of economy.
Scientific mining operations accompanied by ecological restoration and regeneration of mined wastelands and judicious use of geological resources, with search for eco-friendly substitutes and alternatives must provide sensational revelation to the impact of mining on human ecosystem (Surender Singh Chauhan, 2010).

Unfortunately in most regions of earth, the underground geological resources (minerals) are superimposed by above ground biological resources (forests). This is particularly more prominent in India. Hence mining operations necessarily involves deforestation, habitat destruction and biodiversity erosion. The extraction and processing of ores and minerals also lead to widespread environmental pollution.

Environmental destruction is the price mankind has to pay for unsustainable development. Alarming increase in indiscriminate sand mining has caused serious damage to the river system of Tamil nadu. As the demand for sand increases in industry and construction, leads to indiscriminate mining of sand from the rivers. The quantum of sand mined every year is several fold more than what flows down and accumulate in the riverbeds. This situation creates a serious environmental threat to the riverine system. On the other hand sand is an essential construction material and it gives employment to a large sector in our state. So the complete banning of sand mining is not a practicable solution to this multidisciplinary problem. A balanced amount of sand mining enables the river to maintain its stability. There were several studies reported in this regard, but most of the studies are related to environmental impacts of sand mining rather than the study on sand inflow.

Problems associated with Riverbed erosion, Sand quarry, Encroachment, movement and deposition of sediment in rivers, lakes and estuaries persist through the geologic ages in almost all parts of the earth. The worst affected region is the...
Kaveri delta region where in several breaches were noticed along the distributaries and irrigation canals. The river beds, which could not resist the excess flow along the Kollidam river has been breached and ultimately the water was allowed to flow in the low-lying areas, affecting many villages in the Kollidam river region. The several breaches due to Kollidam River surrounding areas mostly affected particularly human and millions of property losses. This necessitates a systematic study on the detrimental indicators for the floods that had caused human life and property, the river breaches, affected agricultural properties by using optical remote sensing technology. The GPS would also used to map the river course and mark the breaches through field survey methods. The study would suggest a plan to strength the natural/ artificial levees that control the river course and also suggest the village that would be affected. Using the optical Remote sensing data and field data to create a Geographical Information System Model for disaster reduction in future would generate a geo-spatial data. But the situation is aggravated in recent times with man's increasing interventions with the environment. At present, the quality of available data is extremely uneven. Land use planning based on unreliable data can lead to costly and gross errors. Soil erosion research is a capital-intensive and time-consuming exercise. Global extrapolation on the basis of few data collected by diverse and non-standardized methods can lead to gross errors and it can also lead to costly mistakes and misjudgments on critical policy issues. The riverbed erosion for this problem further, voluminous data gathered with the help of utilized with the help of Geographical Information Systems (GIS). In this case study, GIS inventory and their analysis for assessing soil erosion and soil conservation planning. Scientific management of soil, water and vegetation resources on watershed basis is, very important to arrest erosion and rapid siltation in rivers, lakes and estuaries.
4.2 Sand and Soil Mining- Definition/ Process

UNEP (1992) describes sand mining as “the temporary or permanent lowering of the productive capacity of land”. “Mining is essentially a destructive development activity where ecology suffers at the altar of economy” (Surender Singh Chauhan, 2010). First of all, the soil mass is scraped from upper 2 to 3 meters, which contains mostly clay, silt and sand is purposely saved and stacked aside in heaps. During sand extraction, topsoil layer is peeled and stacked aside and exposed sand is excavated to a depth of 10-12 meters. afterwards, stacked topsoil is spread and mixed with sand bed. As mining proceeds further, the mined fields are handed over to the owner for cultivation. Thick column of sand (light grey) removed and overlying top soil cover (dark grey) pushed down the slope to evenly spread over sandpit. After spreading and mixing top soil with sand, the field is compacted, leveled and bunded to commence cultivation.

4.3 Importance of Sand

Sand has become a very important mineral for our society due to its many uses. It can be used for making concrete, filling roads, building sites, brick-making, making glass, sandpapers, reclamations, and etc. The role of sand is very vital with regards to the protection of the coastal environment. It acts as a buffer against strong tidal waves and storm surges by reducing their impacts as they reach the shoreline. Sand is also a habitat for crustacean species and other related marine organisms. Sand also plays an important role in our tourism industry as it is an integral part of our beach attractions. Each has its own requirements in respect of the quality of the sand. On average, people 'use’ over 200kg of sand per person per year. This sand is taken from what are essentially non-renewable resources.
4.4 Constituents of Sand

Clean sand is indeed a rare commodity on land, but common in sand dunes and beaches. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO2), usually in the form of quartz which because of its chemical inertness and considerable hardness, is the most common mineral resistant to weathering. The bright white sands found in tropical and subtropical coastal settings are eroded limestone and may contain coral and shell fragments in addition to other organic or organically derived fragmental material. The gypsum sand dunes of the White Sands National Monument in New Mexico are famous for their bright, white color. Arkose is a sand or sandstone with considerable feldspar content, derived from the weathering and erosion of a (usually nearby) granitic rock outcrop. Some sands contain magnetite, chlorite, glauconite or gypsum. ISO 14688 grades sands as fine, medium and coarse with ranges 0.063 mm to 0.2 mm, 0.25 mm to 0.50 mm and 0.63 mm to 2.0 mm respectively.

4.5 Sand Mining

Sand Mining is a coastal activity referring to the process of the actual removal of sand from the foreshore including rivers, streams and lakes. Sand is mined from beaches and inland dunes and dredged from ocean beds and river beds. A related process is the mining of mineral sands, such as mineral deposits like diamond, gold and silver. These minerals typically occur combined with ordinary sand. The sand is dug up, the valuable minerals are separated in water by using their different density, and the remaining ordinary sand is re-deposited.
Individuals and private companies are increasingly demanding sand for construction purposes and this has placed immense pressure on sand resources. It is a practice that is becoming an environmental issue as the demand for sand increases in industry and construction.

4.6 River Bed Mining – A large scale Concession and Multiple Problems

Sand is an essential minor mineral used extensively across the country as a useful construction constituent and variety of other uses in sports, agriculture, glass making (a form of sand with high silica content) etc. It is common knowledge that minerals are non-renewable but this form of mineral naturally gets replenished from time to time in a given river system and is very much interrelated to the hydrological cycle in a river basin. But its over-exploitation and indiscriminate mining supersedes replenishment and optimum extraction is overtaken by profits, extraction has exceeded its replenishment rate and it neglects laws of mineral conservation. Sand mining has become a widely spread activity and does not require a huge set up or technology, the number of ventures has increased extensively and it has become a footloose industry in itself but the backward-forward linkages are becoming stronger as many are getting employed as well as the construction activity / industry requires this mineral at consistent rates. In the state of Punjab, sand has been declared as an essential commodity so as to control its extraction and sale price.

Andhra Pradesh on the hand is heading towards a lottery system. Riverine environmental systems are unique in themselves and provide environmental services, natural resources to meet variety of needs of urban and rural communities. The Rivers originating from the Himalayas bring with them lots of aggregate materials where as they move downstream, only finer elements / minerals like sand are found in abundance. Rivers also act as natural administrative boundaries among
the states and this gives rise to improper and unclear demarcation of boundaries as the river keeps changing its course from time to time thereby unclear administrative controls and mechanisms becomes a point of excuse for administration for any illegal activity taking in this disputed area. River Yamuna near Dakpathar barrage leaves Uttarakhand and enters Himachal Pradesh, this spot gives rise to illegal mining on one side and making an easy escape in other administrative boundary. Similarly, River Ravi leaves Jammu and Kashmir (near Lakhanpur) and enters Punjab, unclear boundaries again become an issue of contention and the result is loss of natural wealth to unprecedented rate of extraction while the administration engages in explanations/reasoning. This remains an issue at the macro level.

4.7 Riverbed Erosion-Terms and concepts

Riverbed erosion, degradation or lowering, is a process by which the bed of the stream is eroded to a new lower level at a much faster rate than occurs naturally.

4.7.1 Riverbed Erosion

There are two main processes that contribute to bed erosion:

a. Decrease in sediment supply: This can occur when upstream dams, weirs, catchments, erosion control works, or excavations in the streambed interrupt the natural passage of sediment through the system.

b. Increase in bed slope: This can be as a result of straightening the river, removing a bed control such as a rock bar, weir or crossing, or excavating the bed of the river for extractive industries, recreation or large pump holes.

4.7.2 The Problems due to Riverbed Erosion

Bed lowering can initiate extensive bank erosion because the height of the banks relative to the bed is effectively increased, leaving them more susceptible to
collapse. Riverbed lowering undermines riverbanks, resulting in overall channel
enlargement with all the associated adverse impacts of bank erosion on economic
and environmental values. Cause lowering of river water level. This may deny water
to pumps for irrigation and/or domestic supplies. It may also decrease habitat for in
stream fauna such as fish and platypus Cause lowering of groundwater level in the
adjacent floodplain. This may deny water to Bore wells and adversely affect the
aquifer. Cause downstream siltation that can destroy aquatic habitats and have
adverse impacts on Water quality, water availability, flooding, navigation and
recreational pursuits. Result in damage to infrastructure including bridges, crossings
and pumps.

4.7.3 Activities in Riverbed Erosion

Human activities, which alter the magnitude and/or frequency of stream flow, can
initiate bed Lowering. These include: a. clearing and development of catchments, b.
Diversion of water from one catchment's to another, c. Prolonged flows delivering
irrigation water and d. Lowered tail water levels for tributaries of regulated streams
during floods. Concentration of flow within the channel is due to the construction of
levees, bridges and culverts. Activities which directly alter a stream channel and
which can initiate bed lowering include: Channel straightening/shortening
Straightening or shortening a channel increases. The slope of the bed and the
channel adjusts to the new slope by eroding the streambed and depositing sediment
downstream. Excavation of drainage lines through on-creek swamps, this increase
and concentrates the flow, thus creating greater flow energy. The greater flow
energy is expended by eroding the streambed, banks or both.
4.7.4 Impacts of Erosion

Erosion, the detachment of soil particles, occurs by the action of water, wind, and glacial ice. Only erosion caused by water will be considered here. Water erosion occurs when raindrops, spring runoff, or floodwaters wear away and transport soil particles. Erosion is a complex natural process that has often been accelerated by human activities such as land clearance, agriculture, construction, surface mining, and urbanization. This article focuses primarily on the actual erosion and its impacts on downstream water quality.

4.7.5 Land Degradation

Land degradation is one of the significant impacts arising out of mining and quarrying activity which is mainly in the form of alteration of land structure due to excavation, stacking of top soil and loss of land due to dumping of mine waste and overburden soil. Stone and sand quarrying causes damage to property, depletion of ground water, loss of fertile top soil, degradation of forest land, adverse effect on the aquatic biodiversity and public health. Haphazard quarrying of sand from the riverbeds leads to damage to infrastructure like bridges and roads. The estimated extent of land degradation due to mining and storage of wastes like over burden soil and mine tailings is not available. Under these circumstances, only indirect methods like remote sensing, aerial photography coupled with ground truth may be used to arrive at realistic estimate of the extent of land degradation in any particular region.

4.8 Riverbed Management

4.8.1 River Bed Structures Issue

The use, erection, reconstruction, placement, alteration, extension, removal or demolition of structures in/ on, under or over the beds of rivers and lakes may:

Adversely affect bed stability, water quality, aquatic habitats, migration of fish, flow
regimes, existing legal public access and natural character of river and lake beds, increase the risk of flooding or unnecessarily obstruct navigation.

4.8.2 Encroachment

A structure, or part of a structure, built on another individual's property. Building, part of building, or obstruction that physically intrudes upon, overlaps, or trespasses upon the Property of another; verified by a Survey. Example: A part of the building on lot a. is an encroachment on lot b. This situation probably occurred because of a faulty survey of lot and illegal intrusion in the highway or navigable river is with or without obstruction. An encroachment upon a street or highway is a fixture, such as a wall or fence, which illegally intrudes into or invades the highway or encloses a portion of it, diminishing its width or area, but without closing it to public travel. In the law of easements, where the owner of an easement alters the dominant tenement so as to impose an additional restriction or burden on the tenement, he or she is said to commit an encroachment. Brickline along the river course poses a major obstacle because the clay from the bunds is taken and the bricks are manufactured. Due to this reason, taking more bund clays reduces the height of bunds and allows the free flow of excess water to the nearby villages during seasonal heavy rainfall. (Plate 4.1)

Encroachments along the Kollidam River

Encroachment in the form of Agricultural Activity
4.8.3 Encroachment from flooding

Construction of settlements in flood plains, ignoring the tendency of rivers to flood occasionally, results in situations in which river water encroaches on properties in ways that can prove extremely costly. Here encroachment on flood plains by buildings engenders encroachment by flooding.

4.9 Flood Disaster

4.9.1 Definition for Disaster

Any incident that causes a several disruption to the organizations ability to function on to provide serve to internal or external customers.
4.9.2 Definitions and Basic Concept
The term flood is a general or temporary condition of partial or complete inundation of normally dry land areas from the unusual and rapid accumulation or runoff surface water from and source. A flood is too much of water in the wrong place. Whether it is an inundated city on a single street on a field flooded due to a blocked drain flooding is generally defined as any abnormally high stream flow that overtops the natural or artificial banks of a stream.

4.9.3 Causes of Floods
Flooded areas of land usually start off as very dry land. Heavy rains that pour too much water into rivers and other waterways cause floods. Making these natural channels unable to carry all the water rising water flows over or breaks the banks to the waterways causing the surrounding land to be flooded. Different causes of floods can come from masses of snow melting of tidal waves. Floods are causes not only by rain but also by human changes to the surface of the earth. Forming deforestation, and urbanization increase the runoff from rains thus storms that previously would have caused no flooding today inundate vast areas. The reckless building in vulnerable areas, poor watershed management, and failure to control the flooding also help create the disaster condition

4.9.4 Flood Impact
Flooods have the greatest damage potential of all natural disasters world wide and affect the greatest number of people on a global basis there is evidence that the number of people affected and economic damages resulting from flooding are on the rise at an alarming rate. Society much moves from the current parading of post-disaster response plans and efforts much is undertaken break the current event
disaster cycle. Move then over, there is the need for decision makers to adopt holistic approaches for flood disaster management.

Extreme flooding events are not relegated to the least developed nations, but can also devastate and ravage the most economically advanced and industrialized nations in the least developed there has been catastrophic flooding in Bangladesh, China, India, Germany, Mozambique, Poland, the United States where when floods occur in less developed nations they can affectively wipe out decades of investments in infrastructure seriously cripple economic property and result in thousands of deaths and epidemics. The majority of the deaths associated with such disasters can be found within the most vulnerable members of society, namely women and children's. The greatest tragedy is that most of these deaths associated post traumatic stresses and social and economic hardships can be either avoided or dramatically reduced through pre-during end post disaster investment in preparedness activities and associated infrastructure floodplain policy development effective watershed land use planning flood forecasting and warning systems and response mechanisms.

4.9.5 Flood Hazard Assessment

Timely assessments are valuable over detailed reports. A rapid assessment takes minimum time in compiling, presenting and sharing the collected information on 'impact' and 'needs.' of the situation. Representative coverage of both urban and rural areas: This is important as both vulnerabilities and capacities are different in these two areas. This data is essential to realistically ascertain both needs of the affected and the capacities of different agencies to intervene.

Special focus on vulnerable geographical areas: These include isolated patches in villages and slums in cities and small towns. If not covered in the initial assessment, identify the need to cover these in later assessment and response.
Vulnerability and capacity assessment of local resources: In addition to assessing the damage it is also important to assess the available local (government, voluntary sector and community) resources for relief and recovery. A mixed focus on assessment with planning for relief and recovery. This prevents the time lapse between assessments and planning; contributes to realistic assessment and planning and helps makes affected communities views of response an integral part of assessment. Design indicators of flood intervention impact with affected populations’ perspective of relief and recovery needs. These indicators will reflect the recovery priority of communities (demand) as different from the recovery priority of agencies (supply), which is often based on the agencies area of specialization. These indicators will be later used to evaluate the appropriateness of agency intervention in floods.

**Definition for Disaster:** “Any incident that causes a severe disruption to the organization’s ability to function or to provide service to internal or external customers”

4.10 Sand Mining in India

Sand Mining in India is adversely affecting the rivers, sea, forests & environment. Illegal mining of Sand and the lack of governance, in a big way is causing land degradation and threatened its rivers with extinction. Mining of sand, for instance, is depleting the waters of the rivers. Weak governance and rampant corruption are facilitating uncontrolled and illegal mining of sand and gravel in the rivers, threatening their very existence. This unrestrained and unregulated activity is posing threats of widespread depletion of water resources which may lead to avoidable food shortages and hardships for the people. In Madhya Pradesh the major rivers like Narmada, Chambal, Betwa or Wainganga or numerous rivulets and streams all are being ravaged for their sands. The state government has wittingly lent a helping
hand by exempting the grant of Environmental Clearance to be taken for mining of sand and gravel, neutralizing the provisions made in several central legislations on conservation of environment and mineral resources. A social activist has approached the state high court for quashing of the unconstitutional exemptions so that indiscriminate mining of sand could be put a stop to. Similarly River Bharathapuzha in Kerala has become a victim of indiscriminate sand mining. “Despite numerous prohibitions and regulations, sand mining continues rapidly on the riverbed of the Bharathapuzha. Water tables have dropped dramatically and a land once known for its plentiful rice harvest now faces scarcity of water. In the villages and towns around the river, groundwater levels have fallen drastically and wells are almost perennially dry. The malaise is pretty widespread as many other states, like Gujarat, Karnataka, Tamilnadu, etc., are also victims of unchecked illegal sand-mining the consequences of which are very serious. Rivers of India are already seriously sick. Polluted by industrial and urban effluents, they are also victims of deforestation in their catchments, sequential damming and degradation because of unchecked sand-mining on their banks and beds. Besides, erratic monsoons, induced by changing climate is taking its toll, adversely impacting their capacity to sustain the current levels of economic activities, especially agricultural productivity.

4.10.1 Offshore sand mining: prospects
Mining of off shore sand became a topic of interest recently because of the increasing demand and spiraling cost of river sand for construction purposes. Often proposed as an alternative to beach mining, is offshore sand mining. Extensive studies must be conducted before any offshore mining can be attempted. Offshore sand banks, coral reefs and sea-grass beds diffuse the energy of storm waves; if large quantities of sand are removed from offshore sand banks in locations where...
replenishment would not occur, serious coastal damage would result in the event of a major storm. A complex relationship exists between sand banks, coral reefs, marine biota, current circulation, waves and swells patterns. Offshore mining does present a possibility with an initially high price tag. Sand mining in coastal regions is subject to different regulations throughout the world. While a minimum water depth is commonly used as a restrictive criterion for providing mining licenses in numerous countries. In a general erosion context of sandy coasts, such practices are often (rightly or wrongly) held responsible for beach recession.

4.11 Sand Quarry in Tamil Nadu

Taking cognizance of the indiscriminate quarrying in the river systems in Tamil Nadu while hearing a Public Interest Litigation petition, the High Court of Madras by its order dated 26.7.2002 directed the State Government to constitute a Committee of Experts consisting of Geologists, Environmentalists and Scientists to study the river and river beds in the State with reference to the impact of sand quarrying. Accordingly, the Government constituted a six member High Level Committee, which gave its report to Government. After detailed discussions of the Committee's Report, orders were issued amending the Tamil Nadu Minor Minerals Concession Rules, 1959 by introducing a new rule as Rule 38-A whereby all existing leases for quarrying sand in Government land and permissions / leases granted in ryotwari lands have ceased to exist with effect from 2.10.2003 and also entrusting the sand quarry to the Government through a single Department Viz. the Public Works Department. Accordingly, the Public Works Department started operating sand quarry at 239 locations identified and sold through 171 depots to the users at a price of Rs.1000/- (Rupees one thousand only) per lorry load (2 units) ex-depot. Conceding the request of the public and also to avoid slackness in the construction
activities, recently orders have been issued reducing the sale price of sand to Rs.600/- per lorry load (2 Units) from Rs.1000/-. These orders came to effect from 19.6.2004.

4.12 Sand Quarry in Kollidam River

The Kollidam river Sand Quarry location Places are Anaikarai, Neelathanallur, Thirumanur, Mathanthur, Annakaranpettai. A public hearing brings to light the serious threat sand mining, often illegal, poses to the environmentalists and human rights activists have repeatedly drawn public attention to the possible ecological impact of the indiscriminate mining of sand in the river basins, coastal areas and hill regions of Tamil Nadu. The threat to the livelihoods of local communities from this mindless commercial activity seems to be more real now than ever before.

After intensive studies in different regions and interaction with the affected people, the Campaign for the Protection of Water Resources-Tamil Nadu has identified 15 adverse consequences of sand mining. They include the depletion of groundwater; lesser availability of water for industrial, agricultural and drinking purposes; destruction of agricultural land; loss of employment to farm workers; threat to livelihoods; human rights violations; and damage to roads and bridges.

4.13 Sand Mining an Ecological Threat

Indiscriminate mining of sand in the river basins, coastal areas and hill regions of Southern India particularly in the state of Tamil Nadu has posed serious threats to ecology and social life. Due to mining, the riverbed is exposed to sunlight leading to dry conditions. Hence water availability has fallen down and the available water turns into saline. This in turn affects fish breeding and catch, thus affecting the livelihoods of fisher folk. Sand mining affects irrigation and water supply also. The ecology of the lotic habitat is altered due to sand mining. Sand dunes offer a chance to study the
phenomenon of succession. For example, is a Lake Michigan dune. Mangroves like Rhizophora species and Avicennia species, which harbor prawns and fish, are essential for mineral cycling are affected when coastal sand is mined. But the miners with their money, muscle power and political influence can mine in the areas even after the expiry of their licenses. Because of their selfish attitude they can dig to several meters of depth, removing 4 to 6 times the permitted quota. The miners have to confine themselves to the areas specified and the depth of mining should not exceed 90 cm. The adverse consequences of this activity includes the depletion of groundwater supplies, lesser availability of water for industrial, agricultural and domestic purposes, destruction of cultivable land, loss of employment to farm laborers, threat to livelihoods, human rights violation and damage to roads and bridges.

In certain areas, there is illegal mining for silicon sand. Mining of coastal sand for construction purposes and uranium extraction causes damage to the coastal ecology, resulting in sea erosion affecting fishing communities. Miners encroach into the space used by the fishermen to land their catch and keep the fishing vessels traditionally. The disappearance of sand dunes has made the inland vulnerable to cyclones. Illegal mining results in seawater intrusion leading to the Stalinization of well water and the depletion of groundwater resources.

A contributory factor is that the lorries can operate only at specific hours due to government restrictions and hence they are overloaded with the mined sand and the journeys are accident-prone. Indirectly it causes damage to the roads, bridges and people are affected with the lungs-related diseases because of the dust from these lorries. The miners are responsible for the disharmony in local communities and exploit the caste conflicts to their advantage. It creates rivalry among the village
poor, when miners encourage the local people in mining activities by giving money; it spoils the general morale and human ethical values. Agitators against sand mining have faced custodial violence and human rights violations. Sand mining resulted in the destruction of numerous coconut trees along the river basins affecting the growers who were reaping the benefits for about 100 years. Several people lost their livelihoods. Even several Palmyra trees were destroyed resulting in the migration of agricultural labors; there is an increase in school dropout rates and rise in number of child workers. To have control over this ecological threat for the preservation of lotic and marine ecosystems the government has to enact and enforce stringent laws with effective functioning of the judiciary system.

Environmentalists and soil experts must be consulted for fixing the areas to be used for soil mining with depth specifications. Voluntary agencies can engage themselves in creating awareness about this among the public. Representatives of victims from 13 of the 28 districts of the State gave evidence on the affected river basins included those of the Kollidam in the Thanjavur district, Palar and its tributaries Cheyyar, Araniyar and Kosathalaiyar (Kanchipuram and Thiruvallur districts); the Cauvery (Karur district); the Bhavani (Erode district); the Vellar (Perambalur district); the Vaigai (Madurai and Theni districts); and the Thamiraparani (Tirunelveli district). Victims from the coastal districts of Nagapattinam, Tuticorin, Ramanathapuram and Kanyakumari and the hill regions of Salem and Erode districts also appeared before the panel and narrated their tales of woe.

Continued sand mining has led to obstruction in the free flow of water during the monsoon, and the volume of water that flows into the Veeranam Tank. This reduction in the availability of sweet water has brought down the fish catch substantially, thus affecting the livelihoods of hundreds of families of fisher folk. The
sand mining has also hindered the flow of water into the heavily silted Anaikarai and Neelathanallur thereby posing a serious threat to Chennai's water supply system. The Kollidam basin mostly serves the ever-increasing sand needs of builders in and around the towns and therefore is the most exploited of the river basins in the State.

The background note says that mining operations, both legal and illegal, have been noticed in a number of places and the norm regarding the depth of the mine is often flouted. Irrigation and drinking water supply are the major casualties. Besides, Lorries that are overloaded with sand damage village roads. In some places, houses are found to have developed cracks. Also, the people in the region are exposed to lungs-related diseases because of the dust emanating from the sand-laden Lorries. And whenever the mining licenses face trouble from the local community, they use their workers, most of who were until recently farm labours, against their own people, thus causing disharmony in the community. Sometimes the miners use the caste divisions in these villages to their advantage. She also detailed the damage caused to the mangrove ecosystem. When some 1,000 protesters led by her staged dharnas before sand-laden Lorries, 15 of them were arrested.

4.14 Sand Quarrying: Environmental Impact

The study concluded with the problems associated with the uncontrolled sand mining for construction industries brings other social problems along the river beds. The study also indicate from the GPS maps about the legal and illegal land quarrying, the illegal quarrying is in the abnormal limit due to higher black market prices. During high flood season the villages in the nearby area is worst affected along the Kollidam river places like Anaikarai, Vadapathi, Kudithangi, Vazhkkai, Puthur, Pattugudi, Devangudi, Anaigudi, Tenkatchiperumalnattum, Annakaranpettai and Karuppur. Other obstructing activities along the Kollidam riverbank such as bricklin industries
encroachments like permanent and semi permanent settlements and leased agriculture lands. This resulting, several breaches along the river during seasonal rainfall and heavy flooding several villages are inundated and affecting rural population. To overcome this type of problem a proper management of sand quarrying and elimination of encroachments along the river banks to reduce pressure of water along the riverbanks. In the meantime the Government of Tamil Nadu has allotted 3,000,000 of Indian rupees to the Public Works Department for the repair works, damaged during the recent floods. The work relating to strengthening bunds, removal of encroachments and monitoring the illegal sand mining had been in progress. (Plate-4.2)

Locations of sand quarries

Parking Yard

Legal Sand Quarries
The Kollidam River, with its banks eroded as a result of legal and illegal sand mining for quite a long time and since the rise in prices of sand for construction industries. A field investigation reveals that the Kollidam basin is one of the most affected river basins in Tamil Nadu by over exploitation of sand. Removal of sand for the extensive illegal mining for silicon sand had resulted in depletion of groundwater and consequently affects agriculture activities in the nearby villages. With drain canals blocked, agricultural lands were getting flooded in several places due to Sand mining and riverbed encroachment, Breeches and the activities of the bricklin work. This necessitates a field level investigation and information gathering using GPS technology and maps the variables to derive a possible solution.

The study area covered three district namely Thanjavur, Trichy, and Perambalur district. From the above district some taluks comes under the study area. The names of the taluks are Thiruvaikulam, Thanjavur, Papanasam, Kumbakonam, and Thiruvadaimarudur from the Thanjavur district, Lalgudi taluk from the Thiruchirappalli district and Ariyalur, Udaiyarpalaiyam taluk from the Perambalur district respectively. The latitudinal and longitudinal extension is from 10°15’ N to 11°15’N and 78°30’E to 79°30’E. It is bounded on the Northern side in Manchanallur
taluks, southern side in orathanadu taluks, and Eastern side in Cuddalore district. The taluks of the districts Thanjavur, Trichy, Perambalur were prepared using the Indian Topographical sheet. The sheets were scanned and then digitized using Arc GIS to convert them in the form of digital map. The map was traced from the villages to taluks trace all the minute details for the flood disaster assessment in the study area.

Figure- 4.1 shows the taluk names: Thanjavur, Thiruvaiyaru, Papanasam, Kumbakonam, Thiruvvidaimarudur, Lalgudi, Ariyalur and Udayarpalaiyam boundaries along with the flood related breaches of rivers, streams, tanks, settlements and with the roads. The river Cauvery and its tributaries are the most remarkable feature of Thanjavur District. Cauvery is considered to be the best of the river that drain the Southern Peninsular of India. The river flows from Karnataka State and passes through Dharmapuri, Salem, Erode, Thiruchirappali Thanjavur, Thiruvarur and Nagapattinam districts covering a distance of about 770 kms, draining an area about 72,800 sq.kms. In all Springing from a spot lying on Brahmagiri Mountains on Western-ghats at a height of 1,320 meters above sea level, Cauvery meanders its way across Karnataka and Tamilnadu and showering not only economic prosperity of millions of people but also carving a riche for itself in their lives in historical, culture and religious realms.
Figure-4.2 shows the location of legal sand quarry in this Kollidam river. The sand quarry places Anaikarai, Neelathanallur, Thirumanur, Mathanathur and Annakaranpettai. The amount of sand carry on from Anaikarai was 110 units per day and 40,150 units per year. The amount of sand carry on from Neelathanallur was 90 units per day and 32,850 units per year. The amount of sand carry on from Thirumanur was 70 units per day and 12,775 units per year. The amount of sand carry on from Mathanathur was 60 units per day and 21900 units per year. The amount of sand carry on from Annakaranpettai was 40 units per day and 14,600 units per year. This was shown in the table –4.1.
Table – 4.1  
Legal Sand Quarry Details

<table>
<thead>
<tr>
<th>S.No</th>
<th>Sand Quarry Name</th>
<th>Amount of Sand per day (unit)</th>
<th>Per year (Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thirumanur</td>
<td>70</td>
<td>12,775</td>
</tr>
<tr>
<td>2</td>
<td>Neelathanallur</td>
<td>90</td>
<td>32,850</td>
</tr>
<tr>
<td>3</td>
<td>Annakaranpettai</td>
<td>40</td>
<td>14,600</td>
</tr>
<tr>
<td>4</td>
<td>Mathanathur</td>
<td>60</td>
<td>21,900</td>
</tr>
<tr>
<td>5</td>
<td>Anaikarai</td>
<td>110</td>
<td>40,150</td>
</tr>
</tbody>
</table>

Source: Public Works Department, Thanjavur

Figure-4.3 shows the Location of illegal sand quarry in this kollidam river. The illegal sand quarry places are: Kadamangudi, Anur, Kudithangi, Thiruvaikavur, Thirupurambiyam, Kudikadu, Pattugudi, Devangudi, Veeramangudi, Anaigudi, Vilangudi, Periyamarai, Alagiyamanavalayam, Kuruvadi, Thuttur, Vaippur,
Arankottai, Melakudikadu, Tenkatchiperumalnattum, Karuppur. The amount of sand carry on the illegal sand quarry places is shown in the table – 4.2.

Table – 4.2
Illegal Sand Quarry Details

<table>
<thead>
<tr>
<th>S.No</th>
<th>Sand Quarry Name</th>
<th>Amount of Sand per day (unit)</th>
<th>Per year (unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kadamangudi</td>
<td>16</td>
<td>5,840</td>
</tr>
<tr>
<td>2</td>
<td>Anur</td>
<td>12</td>
<td>4,380</td>
</tr>
<tr>
<td>3</td>
<td>Kudithangi</td>
<td>18</td>
<td>6,570</td>
</tr>
<tr>
<td>5</td>
<td>Thirupurambiyam</td>
<td>19</td>
<td>6,935</td>
</tr>
<tr>
<td>6</td>
<td>Kudikadu</td>
<td>15</td>
<td>5,475</td>
</tr>
<tr>
<td>7</td>
<td>Pattugudi</td>
<td>15</td>
<td>5,475</td>
</tr>
<tr>
<td>8</td>
<td>Devangudi</td>
<td>10</td>
<td>3,650</td>
</tr>
<tr>
<td>9</td>
<td>Veeramangudi</td>
<td>13</td>
<td>4,745</td>
</tr>
<tr>
<td>10</td>
<td>Anaigudi</td>
<td>11</td>
<td>4,015</td>
</tr>
<tr>
<td>11</td>
<td>Vilangudi</td>
<td>14</td>
<td>5,110</td>
</tr>
<tr>
<td>12</td>
<td>Periyamarai</td>
<td>8</td>
<td>2,920</td>
</tr>
<tr>
<td>13</td>
<td>Alagiyamanavalam</td>
<td>10</td>
<td>3,650</td>
</tr>
<tr>
<td>14</td>
<td>Kuruvadi</td>
<td>15</td>
<td>5,475</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Location</th>
<th></th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Thuttur</td>
<td></td>
<td>5,110</td>
</tr>
<tr>
<td>16</td>
<td>Vaippur</td>
<td></td>
<td>4,745</td>
</tr>
<tr>
<td>17</td>
<td>Arankottai</td>
<td></td>
<td>6,570</td>
</tr>
<tr>
<td>18</td>
<td>Melakudikadu</td>
<td></td>
<td>4,380</td>
</tr>
<tr>
<td>19</td>
<td>Tenkatchiperumalnattum</td>
<td></td>
<td>5,110</td>
</tr>
<tr>
<td>20</td>
<td>Karuppur</td>
<td></td>
<td>5,475</td>
</tr>
</tbody>
</table>

Source: Data gathered through Field Survey

Figure-4.4 indicates the location of Bricklin activities in this region. The Bricklin activity places are: Gurukur, Kudithangi, Thirupurambyam, Kudikadu, Pattukudi, Chinnakudikadu, Thiruvenganur, Karaikuruchi, Vazhaikuruchi, Annakaranpettai and Karuppur. During this activity the sand was carry on from the Kollidam River. Due to this activity the riverbed areas get eroded.

Figure-4.5 shows the Location of Riverbed encroachment in the Kollidam river region. In the encroachment areas agricultural practices are also seen. Crops such as Paddy, Coconut, Sugarcane, Pulses are seen among it vegetables such as...
Brinjal, Ladies finger, Reddish and some species such as Chilies, Turmeric are also cultivated in this region. All the agricultural practices are shown in map as plantation area. Due to these Huts, plantation in the encroachment area in the riverbed region, water is blocked and gets stagnated and the breaches occur and let to flooding condition and it is given in table-4.3.

Table – 4.3

River Encroachment along the River Kollidam

<table>
<thead>
<tr>
<th>S.No</th>
<th>Division</th>
<th>Total Area</th>
<th>Encroachment Area</th>
<th>Type of Encroachment</th>
<th>Number of Encroachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kollidam</td>
<td>107.33</td>
<td>0161</td>
<td>Veli</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Kollidam</td>
<td>55.03</td>
<td>55.03</td>
<td>Kodukapali</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Kollidam</td>
<td>1.37</td>
<td>1.37</td>
<td>Sugarcane</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Kollidam</td>
<td>0.80</td>
<td>0.80</td>
<td>Sugarcane</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Kollidam</td>
<td>0.50</td>
<td>0.50</td>
<td>Sugarcane</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Kollidam</td>
<td>2.12</td>
<td>0.07</td>
<td>Coconut</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Kollidam</td>
<td>145.65</td>
<td>0.20</td>
<td>Plantain</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Location</td>
<td>Latitude</td>
<td>Longitude</td>
<td>Type</td>
<td>Count</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>----------</td>
<td>-----------</td>
<td>----------------</td>
<td>-------</td>
</tr>
<tr>
<td>8</td>
<td>Kollidam</td>
<td>1.66</td>
<td>0.11</td>
<td>Huts and Veli</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>Kollidam</td>
<td>0.86</td>
<td>0.02</td>
<td>Huts</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Kollidam</td>
<td>4.01</td>
<td>0.02</td>
<td>Huts&amp;Coconut</td>
<td>14</td>
</tr>
<tr>
<td>11</td>
<td>Kollidam</td>
<td>1.75</td>
<td>0.05</td>
<td>Huts</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>Kollidam</td>
<td>0.19</td>
<td>0.01</td>
<td>Veli</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>321.27</strong></td>
<td><strong>219.18</strong></td>
<td><strong>49</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Taluks Administrative Offices, Thanjavur

Figure-4.6 depicts contour map showing the lines connecting places having low and high elevation. This was prepared using the Indian Topographical sheets. The collected information of latitude and longitude and the height parameters were then computed using the SURFER Package and finally the contour map was derived. The areas between the contour lines were identified as flood affected area, because the low laying area was severely affected. The map shows the General relief is from North part of the zone there is an elevated area of having the height of 120 meters, than constantly decreased the Elevation of 20 metres. East and southeast part of the area are low elevated and gentle slopes. There has been an increase in height towards North south.
4.15 Flood Vulnerability Map using Rainfall, Discharge and Breaches Data

Emerging as a small rivulet from the Coorg Mountains the river Cauvery expands rapidly increasing in volume, as hundreds of streams and rivulet merge with it which are mostly fed on the heavy rainfall of the south-West monsoon. After Sivasamudram Falls in Mysore, the Cauvery again forms beautiful waterfalls at Hoganekal in Dharmapuri District. The three minor tributaries, Palar, Chennar and Thoppar enter into the Cauvery on her course, above Mettur, where the famous dam has been constructed. The Mettur dam joins the Sita and Pala mountains beyond that valley through which the Cauvery flow, up to the Grand Anicut. The dam in Mettur, impounds water not only for the improvement of irrigation but also to ensure the regular and sufficient of water to the important Hydro-Electric generating station...
at Mettur. The river further runs through Erode district where river Bhavani merges with it. While passing through Erode, two more tributaries vice versa. Noyyal and Amaravathi join it before reaches Thiruchirappalli district. Here the river becomes wide, with a sandy bed and flows in an easterly direction till splits into two at upper anicut about 14 kilometres west of Thiruchirappalli. The northern branch of river is called the Coleroon while the southern branch retains the same name Cauvery and then goes directly eastwards into Thanjavur District. These two rivers join again and form the Srirangam island near Thiruchirappalli.

The CholaKing, “Karikalan” has been immortalised as he has constructed the bank for the Cauvery all the way from Puhar (Kaveripooppattinam) to Srirangam. It was built as far back as 1,600 years ago or even more. On both sides of the river are found walls spreading to a distance of 1,080 feet. The dam Kallanai on the border between Tiruchirappalli and Thanjavur constructed by him is a superb work of engineering, which was constructed with earth and stone and has stood the vagaries of nature for hundreds of years. In 19th century, it was renovated in a bigger scale. The name of the historical dam has since been changed to “Grand Anicut” and stands as the head of great irrigation system in the Thanjavur district. From this point, the Coloroon runs north-east and discharges herself into the sea at Devakottai, a little south of Parangipettai. From river Coleroon, Manniar and Uppanai Branch of at lower Anicut and irrigate a portion of Mayiladuthurai taluk and Sirkazhi taluk. After Grand Anicut, the Cauvery divides into numerous branches and cover the whole of the delta with a vast network of irrigation channels and gets lost in the wide expanse of paddy fields. The mighty Cauvery river here is reduced to an insignificant channel and falls into the Bay of Bengal at the historical place of Poompuhar.
(Kaveripoompatinam) about 13 kms north of Tharangampadi. The river Cauvery flows the entire district in different names through its tributaries and branches (Figure - 4.7)

GRAND ANICUT COMPLEX : A MODEL

Figure 4.7

When there is flow in Cauvery River, natural recharge is taking place in the delta area. With surface water availability not guaranteed, to the full extent, at a time when it is needed, people resorted to exploit the ground water in large proportions. This has caused lowering of water table in the area especially in summer months. In Thanjavur district, coastal habitations are facing severe drinking water supply problems especially in summer. A stage has come to sink deep tube
wells to augment water supply in areas where shallow open wells are serving as the source of drinking water supply. To avoid further continuation of such a precarious situation, Government of Tamil Nadu timely thought it is necessary to arrest further depletion of water level by adopting suitable techniques of artificially recharging the groundwater aquifer.

Figure - 4.8 indicates the all taluk Breaches area with GPS data map its shows GPS sample points, breaches along the rivers and tanks Global Positioning System (GPS) was also used to trace the breaches that had transpired during flood situation. The breaches were occurred due to the continuous down poring resulting overflow along the Kollidam Rivers in this region.

Figure - 4.9 implies the flood zone maps and breaches in this region. The excess of flow had entered the low-lying areas causes' heavy damage to the villages in this region.
taluk. The major breaches in particular areas (Vazhkkai) mostly affected in the surrounding area. And other breaches areas Anaikarai, Vadapathi, Iyanallur, Kudithangi, Puthur, Pattugudi, Devangudi, Anaigudi, Veeramangudi and Maharajapuram.

The vulnerability analysis maps (Figure - 4.10) towards the impact of floods in general and on agriculture in particular along with the GPS field data about the breaches, along the tanks and the rivers and based on the contours maps. The vulnerability map was overlaid in the study area map that shows the area, which is more vulnerable from the present analytical study.
There are five classes of Very low (less than 20 per cent), Low (21-40 per cent), Moderate (41–60 per cent), High (61–80 per cent), and Very high (above 80 per cent) vulnerable zones were categories.
According to the integrated analysis of GPS and GIS data, Very high vulnerable zones are founding Vazhkkai, Veeramangudi, Thiruvaikavur, Thirupurambiyam, Kudikadu, Manalmedu, Anur, Vadapathi, Puthur, Pattugudi, Anaigudi, Tenkatchiperumalnattum, Annakaranpettai, Karuppur these villages, because of the presents of Kollidam river with number of breaches. High zones are found Cholapuram, Asur, Thiruvaigayar, because of the overflow of Manniyaru River. Moderate zones are found southern side areas, Low zones are found in the Thirumanur, Karaikuruchi, Thirumanur, Kangaikondacholapuram, Palur in the areas Very low zones are found in the northern side areas.

4.16 Public Perception on Sand Mining Activities in Kollidam River

Large scale mining of sand and gravel several folds higher than the natural replenishments, has led to irreparable damages to the land, water, biotic and social
environments related to many of the world’s river systems. Sand mining disturbs the equilibrium of a river channel because it intercepts material load moving within a dynamic system and triggers an initial morphological response to regain the balance between supply and transport. The present chapter deals with the public perception towards sand mining activities in Kollidam River with reference to socio-economic, demographic profile of the respondents, impact of sand mining on agriculture, public and environment, causes of flooding and its effects on community indeed.

4.16.1 Conceptual Background

Cases of water table lowering consequent to sand and gravel mining have been documented by several investigators. Planning Department of the Lake County, California in l992 has estimated that the potential reduction in alluvial aquifer storage consequent to channel incision caused by instream mining ranges from l to 1.6 Per cent, depending on local geology and aquifer geometry (Lake County, 1992). Lowering of groundwater table has been documented along the Russian River of the Sonoma County in the year 1992 (Kondolf, I998). Kondolf et al. (2002) while reviewing the effects of sand and gravel mining on various environmental components opined that channel incision consequent to indiscriminate sand mining can accelerate the pace of groundwater lowering in areas adjacent to river channels. Mitchell (2006) has also made an attempt to study the relation between gravel mining and water supply wells in Maine, U.S.A., and found that mining processes have a direct bearing on water table levels in the area.

Channel incision due to sand mining, typically lowers the alluvial water table as the channel itself determines the level down to which the alluvial groundwater drains (Galay, 1983; Creuz des Chatelliers and Reygrobellet, I990; This results in loss of groundwater storage and influences alluvial groundwater-surface water
exchanges along the river system. The survey conducted by Prasad and Nair (2004) in the area between Panthalam and Thumpamon reveals that out of the total 53 wells, 36 percent are perennial and 64 percent are seasonal, drying up for varying durations.

Human activities have disrupted the natural flow patterns and ecological processes of rivers with adverse affects on their biological wealth (Pctts, 1984; Moyle and Leidy, 1992). Reports suggested that the indiscriminate sand mining has changed the ecology of the river systems along vast stretches during the past few decades (Anon, 2005). Parker (1996) states that any adverse effects on the hydrological environment of developing countries will tend to have a corresponding affect on the health of local communities. In many parts of the developing world, communities near to extractive operations depend on untreated surface and ground waters as their main water supplies, used for drinking, washing and food preparation. Extraction from riverbanks and beds and the resultant generation of particulates, chemical pollutants such as diesel in the water therefore pose a particular health risk to workers involved in mining. The excavations associated with river mining can create stagnant waters that may favour the multiplication of waterborne disease vectors such as flies, mosquitoes and other parasites and the introduction of new ones. Resurgence in the incidence of vector borne diseases like Dengue fever, Chikungunya, Japanese encephalitis etc., is one of the most worrying changes in disease patterns in recent years(KSCSTE, 2007).

River sand extraction is linked to some small population increases as a result of its potential direct and indirect employment opportunities. The wages they receive can cause huge disparities of wealth in a concentrated area (Clark, 1996). Water table lowering can induce profound ecological and landscape changes, including
loss of hyporheic habitat as adjacent banks are dewatered (Creuze des Chatelliers and Reygrobellet, 1990).

### 4.16.2 Significance of the Present Study

Sand mining is a practice that is used to extract sand, mainly through an open pit and it can have adverse environmental and social consequences. Mining is essentially a destructive development activity where ecology suffers at the altar of economy. Sand has been used in the construction of roads and buildings. Today, demand for sand continues to increase. Excessive sand mining is a threat to bridges, river banks and nearby structures. Sand mining also affects the adjoining groundwater system and the uses that local people make of the river. Sand mining generates extra vehicle traffic, which negatively impairs the environment. Where access roads cross riparian areas, the local environment may be impacted. Sand mining in stream channels can damage public and private property. Apart from threatening bridges, sand mining transforms the river beds into large and deep pits; as a result, the groundwater table drops leaving the drinking water wells on the embankments of these rivers dry. Bed degradation lowers the elevation of stream flow and the floodplain water table which in turn can eliminate water table. Sand mining activities will have an impact upon the river's water quality. Increased riverbed and bank erosion increases suspended solids in the water at the excavation site and downstream. Suspended solids may adversely affect water users and aquatic ecosystems. Mining which leads to the removal of channel substrate, re-suspension of streambed sediment and clearance of vegetation will have ecological impacts. In this juncture, the present chapter is analyzing the public perception towards sand mining activities in Kollidam River.
4.16.3 Problem under study

The present chapter is to analyse the public perception towards sand mining activities in Kollidam River; with the following priorities.

a. To evaluate the socio-economic and demographic profiles of respondents.
b. To probe in to the public perception towards sand mining activities.
c. To investigate the socio-environmental impact of sand mining, interrelationships and interdependence with the selected variables based on experiences, observation and perception of local people.

4.16.4 Mode of Analysis

The present study is based on questionnaire survey by direct observation method, 700 public people who reside along and near the Kollidam River have been selected based on the random sampling procedure, based on the fact that this is a social problem that everyone is either directly or indirectly affected through the sand mining activity. The questions are related to socio-economic, demographic, environmental, health and psychological characters with reference to sand mining activities. The information collected through the questionnaire has been transformed into 62 selected variables and entered into SPSS for the application of statistical technique to find out the association. These variables are assumed to be the important to analyze the existing social problems of sand mining. Factor analysis was employed for the present data structure and accordingly a matrix of 700x62 were subjected to dimension reduction process. 9 out of 62 variables were extracted for the interpretation purpose of present study. So the data were reduced to 9x9 inter correlation matrix to facilitate for easy interpretation. In addition to the above the factor loading matrix was used to explain the strength of relationship and the variance of each variable with all other variables.(Plate 4.3)
Primary data Gathering in sample village
4.16.5 Findings

The application of factor analysis for the present study is extremely constructive in separating the major dimensions towards the perception of sand mining and its impact on environment. Accordingly, five foremost dimensions were identified and contributing a total variance of 75.279 per cent. An Eigen value of 1 is taken as a cut-off point (Yeats 1974) to determine the number of dimensions to be extracted. Correlation matrix revealed the presence of many coefficients of .4 and above. The Kaiser-Meyer-Oklin (KMO) value was 0.635, exceeding the recommended value of 0.6 and the Bartlett’s Test of Sphericity reached statistical significance (0.000), supporting the factorability of the correlation matrix. Principal components analysis revealed the presence of six components with Eigen values exceeding 1.0.

4.16.6 Socio-Economic Profile

Of the 700 respondents, Male are 388 (55.4 Per cent) and Female are 312 (44.6 Per cent). The respondents are aged between 20 and 80. Their marital statuses were revealed that they were married (78.3 Per cent), unmarried (16.0 Per cent), widow (3.6 Per cent) and widower (2.0 Per cent). The respondent’s family sizes were small (31.0 Per cent), medium (60.7 Per cent) and large (8.3 Per cent). Respondent’s family annual income was less than 50,000, were 84 percent; 50,000 to 100,000 were 14.9 percent and more than 100,000 were 1.1 percent. Educational profiles of the respondents were illustrating that illiterate (26.9 Per cent), elementary (21.6 Per cent), high school (31.1 Per cent), higher secondary (10.4 Per cent), diploma (2.0 Per cent) and degree (8.0 Per cent). Religiously they were belonging to the Hindu (95.1 Per cent), Muslim (3.0 Per cent) and Christian (1.9 Per cent). According to community the respondents were belongs to most backwards are 46.3
percent, backward communities are 36.0 percent, scheduled caste are 16.7 percent and others are 1.0 percent. They were living in thatched roof house (22.4 Per cent), tiled house (40.9 Per cent) and concrete roof house (36.7 Per cent). Living locations of respondents were evidencing that 63.5 percent were near the river, 32.9 percent were near the river and 3.6 were near the sand mining site.

4.16.7 Acuity of Sand Mining

The respondents perception towards sand mining were revealed that 98.4 percent were accepted that it will create a deprived circumstances for future generation particularly the ground water level will goes down (98.3 Per cent) and it affects agricultural practices (78.2 Per cent). They also confirmed that the road ways were damaged little (36.9 Per cent), more (32 Per cent), heavy (23.7 Per cent) very much (7.4 Per cent) and it pave the way for accidents (42.1 Per cent). 67.7 percent of the respondents were stated that the occurrences of flood every year and during heavy rainy season and it leads to water logging for long days/months (64.35), breaking of river embankments (98.8 Per cent), crop damage (58.25) and fatality of household animal like hen, sheep and cow. However, the respondents were reported that in the year 2004, 2005 and 2008 there was a heavy damage were occurred by breaking of river embankments and which cause flooding 11.8 percent, 62.9 percent and 11.0 percent respectively. Accordingly, the crop land under one acre (33 Per cent), one to three acres (24.6 Per cent) and above three acres (42.4 Per cent) were destroyed. Thus, the cost of damages are less than Rs. 5,000 were 9.8 percent, Rs. 5001 to 10,000 were 18.5 percent, Rs. 10,001 to 20,000 were 24.6 percent, Rs. 20,001 to 30,000 were 19.2 percent and more than 30,001 were 27.9 percent. Therefore, 45.7 percent of the respondents were confirmed that they have received
compensation for their crop damages from the Tamil Nadu State Government depends upon the crop cultivated area.

Subsequently, flooding cause head ache (8.95), diarrhoea (16.2 Per cent), fever (51.4 Per cent), cold and fever (19.1 Per cent), malaria (3.4 Per cent) and other health problems for civic people. 86.7 percent of the respondents were reported that they find difficulties to go out from their residential area. Particularly, the hitches were road submerged into water (31.4 Per cent), heavy road damages (41.1 Per cent), broken road (17.4 Per cent) and cut off public transportation. Throughout the flood season, the people were having lack of drinking water facilities 82.1 percent of the respondents were reported that they have being affected by sand mining and its allied activities (excavation, escalators, heavy vehicle and transportation and deposition of sand heaps). These directing physiological problems like eye irritation (13.7 Per cent), head ache (25.8 Per cent), itching on the head (12.8 Per cent), body itching (12.5 Per cent), asthma (12.5 Per cent) fine sand dust depositing in nose and ear (14.9 Per cent). The respondents were also confirmed that the sand mining activities were shapes agricultural activity, productivity and lowering of ground water level.

The respondents were also revealed that they were unable to sleep (84.0 Per cent), walk (8.5 Per cent), cross the road (5.3 Per cent) and unable to play (2.2 Per cent) because of heavy vehicle movement and its noises. They also accepted that the sand mining is unavoidable, profit to the contractors and governments. But the government can locate the sand quarry or mine away from the settlement area even then they can transport the sand during night time to avoid accidents and other problems.
4.17 Discussions

4.17.1 Factor I: Impact of Sand Mining on Agriculture

Agricultural activities are base for Indian economy and it full fills our food requirements. “Impact on Agriculture” has been emerged as a single most vital factor with an Eigen value of 1.727 and the total variance of 19.194 percent (Table 4.4 and table 4.5). Two out of nine variables were loaded on this factor. This is clearly indicating that the variables ground water level goes down (0.911) and crop damage (0.907) were highly correlated with sand mining. This is also confirmed with the respondents views that 98.3 percent of the respondents were revealed that the ground water level were comes down less than five feet (8.0 Per cent), 6 to 10 feet (16.6 Per cent), 10 to 15 feet (26.1 Per cent) and above sixteen were (49.3 Per cent). Similarly, 58.2 percent of the respondents were conveyed that their crop has been dried out during summer because of demand and low supply of bore well water. They also informed that paddy (62.1 Per cent), sugarcane (6.9 Per cent), green chilly (4.7 Per cent) and maize crops were damaged because less supply of underground water sources. Therefore, the cultivable land area and the productivity has been comes down. This has immediate impact on the vegetable market in terms of high prices due to less supply and high demand in urban area. These were undoubtedly proving that the sand mining was affecting the agricultural activities and practice.
Table 4.4  
Factor Loading

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name of the Factor</th>
<th>Variable No</th>
<th>Name of the Variable</th>
<th>Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Impact on Agriculture</td>
<td>14</td>
<td>Ground water level goes down</td>
<td>0.911</td>
</tr>
<tr>
<td></td>
<td></td>
<td>29</td>
<td>Crop damage</td>
<td>0.907</td>
</tr>
<tr>
<td>II</td>
<td>Impact on Public</td>
<td>35</td>
<td>Difficult to go out from the residential area</td>
<td>0.792</td>
</tr>
<tr>
<td></td>
<td></td>
<td>38</td>
<td>Health problems by sand mining</td>
<td>0.712</td>
</tr>
<tr>
<td></td>
<td></td>
<td>37</td>
<td>Drinking water problem</td>
<td>0.701</td>
</tr>
<tr>
<td>III</td>
<td>Flooding</td>
<td>26</td>
<td>Flood has reached by the collision of river embankment</td>
<td>0.764</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27</td>
<td>Loss of life during the flood</td>
<td>0.717</td>
</tr>
<tr>
<td>IV</td>
<td>Awful Road Ways</td>
<td>16</td>
<td>Road damaged by sand carriers</td>
<td>0.972</td>
</tr>
<tr>
<td>V</td>
<td>Accidents</td>
<td>17</td>
<td>Accidents by sand carriers</td>
<td>0.936</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.  
Rotation Method: Varimax with Kaiser Normalization.

Source: Results of Factor Analysis using SPSS

4.17.2 Factor II: Impact of Sand Mining on Public

The factor “Impact on Public” has with an Eigen value of 1.641 and the total variance of 18.228 percent (table 4.4 and table 4.5). There were three positive loadings on the variables: difficult to go out from the residential area (0.792), health problems by sand mining (0.712) and drinking water problems (0.701). These were unambiguously showing that the sand mining activities were responsible for the respondent’s conception. Therefore, the respondents (86.7 Per cent) were expressed that during sand mining activities one cannot go out of their houses due to sand carriers/trucks/lorries because of vehicle speed, sand dust and accident. This is further confirmed with other variable health problems by sand mining in which eye irritation (13.7 Per cent), head ache (25.8 Per cent), itching on head (12.8 Per cent), body (12.5 Per cent), nose (11.6 Per cent) and ear (3.6 Per cent), asthma (12.5 Per cent) formation of phlegm (5.2 Per cent) and other problems (2.0 Per cent). 35.51
percent of the respondents were confirmed that many were gave last breaths to the sand carriers. 98.3 percent of the respondents were experienced and stated that they have been facing acute shortages of drinking water supply during summer season. The sand is having high porosity which allows water to percolate into the underground. Once, this sand were removed from the river bed there is no chance of groundwater recharge and it leads to lowering down of water table due to excavation of sand from the river bed. This factor is also noticeably proved that the sand quarries were threatening the public.

4.17.3 Factor III: Cause of Flooding

It is one of the natural calamity, caused by heavy torrential rain and create severe damage to socio and economic problems. In this study “Flooding” formed as a third factor with an Eigen value of 1.292 and the total variance of 14.353 percent. The high positive loadings were found on the variables flood has reached by the collision of river embankment (0.764) and loss of life during flood (0.717).

<table>
<thead>
<tr>
<th>Variable No.</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Communalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>0.911</td>
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<td></td>
<td></td>
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<td>0.836</td>
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<td>0.628</td>
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<tr>
<td>38</td>
<td></td>
<td>0.712</td>
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<td>0.608</td>
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<tr>
<td>37</td>
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<td>0.701</td>
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<tr>
<td>26</td>
<td></td>
<td></td>
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<td>16</td>
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<td>0.972</td>
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<td>0.950</td>
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<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.936</td>
<td>0.888</td>
</tr>
<tr>
<td><strong>Eigen values</strong></td>
<td>1.727</td>
<td>1.641</td>
<td>1.292</td>
<td>1.080</td>
<td>1.035</td>
<td>6.775</td>
</tr>
<tr>
<td><strong>Percentage of variance</strong></td>
<td>19.194</td>
<td>18.228</td>
<td>14.353</td>
<td>11.995</td>
<td>11.509</td>
<td>67.509</td>
</tr>
<tr>
<td><strong>Cumulative Percentage</strong></td>
<td>19.194</td>
<td>37.422</td>
<td>51.775</td>
<td>63.770</td>
<td>75.279</td>
<td>100.000</td>
</tr>
</tbody>
</table>

*Source: Data generated from SPSS results of factor analysis*
This is clearly established that the collision of river embankments are due to the man made activities; sand carriers were weakening, thinning and breaking of river bank due to frequent movement of vehicles and water are not able to percolate into the underground soil and it leads to heavy runoff due to the absence or top sand grain soil has been removed. The following are the respondent’s views for flooding. 67.7 percent of the respondents were revealed that the occurrence of floods in their region due to sand mining, 55.0 percent were revealed that the river banks were weak and broken, 59.9 percent were informed that due to human interference and 64.3 percent were informed that they have been facing water logging problems. Further, 62.9 percent of the respondents were accepted that in the year 2005 flood has created severe damages and 54.1 percent were revealed that there were losses of animal as well as human life. Particularly, minimum two to five hen, three to seven sheep and one or two cows were lost by the flooding. Therefore, the respondents were believed that the sand mining activities are the main reasons for all these causes.

4.17.4 Factor IV and V: Awful Road Ways and Accidents

Road is one of the important means of transportation for the movement of people and goods and provides services to the community. Road must be in good condition for the movements of vehicle, it will damage due to frequent heavy loaded sand carriers and cause accidents, injures physical parts and sometimes loss of life. Therefore, “Awful Road Ways” with an Eigen value of 1.080 and the total variance of 11.995 percent and “Accidents” with an Eigen value of 1.035 and the total variance of 11.509 percent (table 4.4 and table 4.5) were emerged as fourth and fifth factor respectively. The variable road damaged by sand carriers (0.972) has high positive loading which has explain by the respondent’s views and they were revealed that the
road were damaged little (36.9 Per cent), more (32.0 Per cent), high (23.7 Per cent) and very high (7.4 Per cent). Similarly, the variable accidents by sand carriers (0.936) were also have high positive loading. This is plainly proven that the respondents (42.1 Per cent) were confirmed that the people were often met with accidents every day during sand mining activities. They also expressed that one (47.6 Per cent), two (21.1 Per cent) and three (31.4 Per cent) children in hundred, one to two teenagers in hundred (62.1 Per cent) one to two adults in hundred (51.5 Per cent) and elders (1.4 Per cent) were injured by the sand carriers during quarry period in this area. As a result, the sand mining activities were manipulating the public life.

4.18 Conclusions

Weak governance and rampant corruption are facilitating illegal mining posing depletion of water resources. The socio-economic significance of mining operations is often overlooked, and there is a need to protect its economic and social benefits. Because of a poor handling of resources, soil and sand mining cause negative impacts to the environment. The system of preparing an EMP report for clearance from the Government of India prior to implementation of mining project has been a positive step of minimizing the negative impacts.

The government should exercise prudence when it comes to leasing out the riverbed for mining activities and also demarcate areas clearly and monitor mining through a suitable institutional mechanism. A high level lobbying committee must be formed and Laws has to be enforced in an efficient and unbiased way and decisive steps are to be taken for environmental solution.

Sand mining activities were facilitating socio-economic and environmental problems in this area and it has strong influence on agricultural activities. Ground
water levels were also decreasing in trend and it has direct impact on public in terms of drinking water supply and agricultural practices. The socio-economic significance of mining operations is often overlooked, and there is a need to protect its economic and social benefits. Because of a poor handling of resources, soil and sand mining causes negative impacts to the environment. The Government of Tamil Nadu prior to implementation of sand mining project has been a positive step of minimizing the negative impacts. The government should exercise prudence when it comes to leasing out the riverbed for mining activities and also demarcate areas clearly and monitor mining through a suitable institutional mechanism. A high level lobbying committee must be formed and Laws has to be enforced in an efficient and unbiased way and decisive steps are to be taken for environmental solution to save our future generation.

Flood disaster is a major problem in the rice bowl of in this region. The river Kaveri brings water to the agriculture lands from the catchments of the Western Ghats parts of Karnataka. For the past ten years due to fluctuating climatic conditions the catchments are not receiving sufficient rainfall and hence the farmers are not able to feed sufficient water to the crops due to dry river conditions. At the same time due to cyclonic and local disturbances during November 2005 this region has received torrential rainfall in a continuous manner filling all the tanks and overflowing the rivers causing major breaches which further allows the excess water to flow in the rural and urban areas and heavy loss to men and materials. The Kaveri delta region of this part has been experiencing this type of conditions for the past three decades. The present study has been made in a systematic way to trace the past flood conditions in the study area and also to compare the present floods (November 2005). To study the impact of floods in the Kollidam River, the latest
technologies like the GIS and GPS were used to derive various digital maps and field survey maps to explain the reasons for heavy flooding. The GPS technology has been used to locate the major breaches along the tanks and the rivers/streams and using the remote sensing and GPS data a vulnerability map has been designed to get information about the low to high vulnerable zone. By using this map the district administration can locate the major disastrous areas to save the life in future. Apart from these observations from the maps the following field observations were also noticed:

a. The artificial embankment near the Manniyar Valkai has completely been destroyed due to floods and this embankment which was constructed a long time back was not properly maintained to withstand the flow of excess water

b. Excess flow of water in Grand Anaicut was allowed to flow in the Tohur village and completely damaged. It is mainly due to the Anaicut was sloping towards the Tohur village causing heavy damages.

c. Along the rivers of Kolli dam there are number of bricklin industries (at small scale) are allowed to practice. During flood situation this would be an obstruction of diversion of water flow to the low lying areas. Similarly sand mining is common in Kolli dam river and it is evident from the physical verification of huge remnants on the rivers and river beds. This would also act as diverting agent of the river course, during floods.

d. From the study it is evident that the Agricultural loss has been very high which is estimated that more than 60 per cent loss. Among the taluks paddy is fully cultivated in Thiruvidaimarudu, Kumbakonam, Papanasam, Thiruvaiyaru and Thanjavur have been damaged due
to flash floods. For this heavy loss the reason is due to several breaches along the river Kollidam, except Thanjavur. and this is the region where several rivers locally known as Kattar confluence and with increased volume of water in the steep slopes in some places.