

# Pakistan's coastal zone — in a climate cha

**G**lobal warming resulting from rising atmospheric CO<sub>2</sub> has been cited to retain heat through the earth's atmospheric, oceanic, and terrestrial systems. As a result ocean water would expand and many glaciers on mountains would melt. This process would lead to higher sea levels.

Sea level rise threatens important environmental and economic assets in the coastal zone. Rising seas will increase the salinity of estuaries, coastal wetlands and aquifers, disrupting marine life and possibly threatening surface/sub-surface drinking water supplies.

Sea level rise also threaten to inundate low-lying land and would intensify coastal erosion process. Globally, a rise in sea level of up to one meter over the next hundred years could severely damage human settlements, agriculture, freshwater supply, fisheries, health and coastal ecosystems. Some of the least developed nations bordering the Indian Ocean are threatened by sea level rise due to a possible impact of climate change.

Observations show that the average temperature of the global ocean has increased to depths of at least 3000m and that the ocean has been taking up over 80per cent of

the heat being added to the climate system.

It is clear that developing countries with large populations in or near deltas and other low-lying areas are especially vulnerable to future sea level rise. One billion people and a third of the world's crop growing areas, will be affected that will endanger the food supply of 200 million people and it could create 50 million environmental refugees.

UNEP (United Nations Environmental Programme) through its OCA/PAC regional seas programme (1989) has grouped Pakistan in the countries, which are most vulnerable to the impacts of a rising sea level.

Pakistan has over 30per cent of its population living in the vicinity of the coastal zone, over 20per cent of coastal area of Pakistan is relatively developed, and 40per cent of industry is situated on or near the coast. Protecting these human assets will be costly, particularly if the effects of climate change are sudden rather than gradual.

A rise sea level of a few mm per year, although not threatening but direct and indirect impact of this rise would have a profound impact on the coastal resources for sustainable coastal zone management.

Direct land loss of low-lying areas can rapidly damage or

destroy coastal ecosystems. In addition to sea level change a rise in global warming will also increase the frequency of tropical cyclones and will further add to the miseries of the coastal states.

The existing information and data on SLR in the archives of the National Institute of Oceanography, Karachi, concurs with the world average rate of increase in sea level.

The predictions of the International Panel of Climate Change predictions suggest that global temperature may increase from 1°C to 3.5°C by 2100. Global average land and ocean surface temperatures increased at a rate of about 0.2°C/decade over the last few decades, and ocean temperatures down to 3000m depth are also on the rise.

Averages rates of sea-level rise over the last several decades were  $1.8 \pm 0.5$  mm/y, with an even larger rate ( $3.1 \pm 0.7$  mm/y) over the last decade.

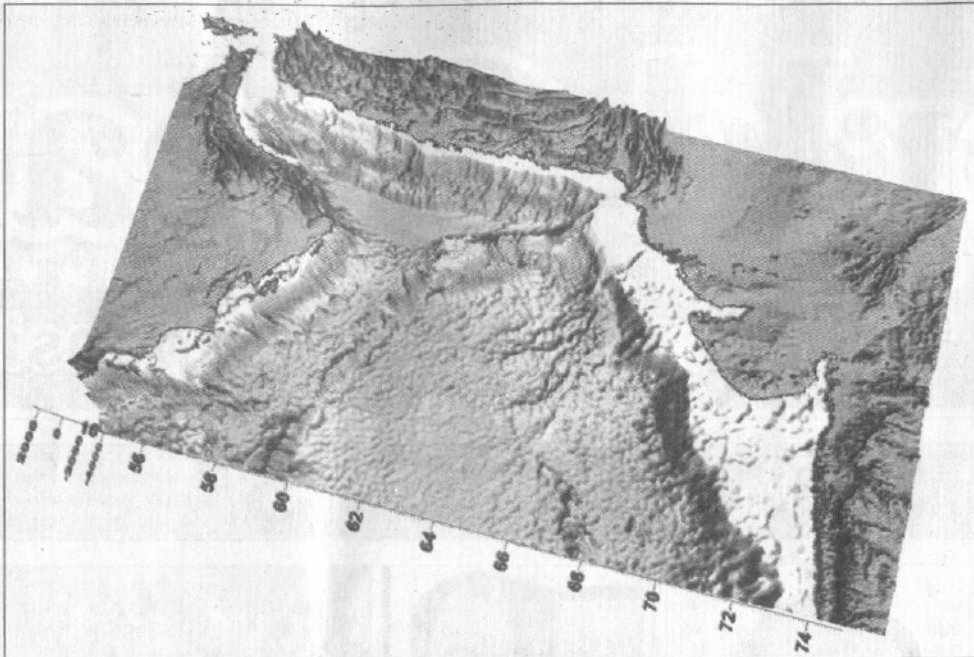
Climate is a dynamic process of Air/Sea interaction. Changes in physics of the ocean or the atmosphere above the oceans may have a direct bearing on our climate. Water circulation induced by atmospheric or oceanic driving forces, mixing of water masses and their physical properties have great bearing on the coastal

processes and environment.

The effects of these forces are related to the productivity, coastal erosion and siltation etc. Arabian

change is very important. Past climatic record of the Arabian Sea shows variability of monsoon climate over a decadal to centennial

changes in monsoon climate effects about a third of Asia-Pacific region. Socio-economic activity of this region is largely associated



Sea has been characterised by very unique oceanographic features as a result of monsoonal climate.

Understanding the role of monsoon climate in Global climatic

time scale (von Rad and Khan, 1999).

Changes in the monsoon intensity have been found correlated with past global climate. Seasonal

with the monsoon climate.

Inter-annual variability has been observed in monsoons that are connected with climatic changes. The continental shelf of

# ange scenario

the Pakistan is a wind-forced shelf, influenced by summer monsoonal winds that are in excess of 30 knots which blow in the south-west direction.

High energy waves in the SW monsoon influences the process of erosion. Coastal upwelling also prevails along Pakistan coast which induce higher primary productivity.

The impacts of the hazards resulting from progressive climate change are apparent all along the coast. The adverse effect of sea level rise on the Pakistan coast is expected to be pronounced in the Indus Delta. Topographically it is a tidal flat zone.

A sea level rise of about 2 metres is expected to submerge an area of about 7,500 sq km in the Indus Delta. The low-lying areas along the Baluchistan coast may also exert a significant effect. The mean sea level (MSL) along the coast at Pasni is about 1.4 m from the chart datum.

The MSL is slowly but gradually rising at a rate of about 1.1 mm/year. Although a small sea level rise may be compensated by tectonic uplift rate of the Makran coastline estimated at 1-2 mm/year at Ormara.

However low lying areas in Gwadar, Gadani may have an impact, and the headland at

Gwadar may be cut off.

This may have an adverse affect on the deep-sea harbour being planned there. At Gadani the local community will have to migrate further inland as the sea gradually advances to higher ground.

These communities will have to be relocated at a greater cost if set back limits are not built into the existing sea level rise policy. The other possible impact of sea level rise would be on the coastal industry such as power plants, ports & harbours, real estate & housing, tourism, coastal fishing/agriculture etc.

Even a modest rise in the sea level will threaten storm barriers and salinate fresh water reservoirs along the coastal belt. The erosion processes (wind and wave) are severe along the Makran coast particularly on coastal cliffs composed of soft rocks.

At places the erosion is as fast as 90cm/ year and the shoreline between the promontories of hard rocks may recede at a very high rate. These changes clearly give an idea of the vulnerability of our coast line to the future sea level rise and climate change.

The primary and secondary impacts and prediction impacts envisaged for the future as a result of sea level rise are discussed in details.