different soils. The study failed to establish any kind of relationship between soil texture and methane entrapment. This indicates the possibility of the involvement of other factors apart from sand, silt and clay content in determining the entrapment pattern of a soil. This emphasizes a need to find out the factors which affect the entrapment of methane in submerged rice soils. Experiments should be carried out with all the different types of rice soils of India to find out the extents of entrapment by these soils, and the effects of different properties of soils on methane entrapment. This will help in understanding the production and emission characteristics of different soils.


Received 25 May 1998; revised accepted 3 August 1998

Coastal morphological influence for tropical cyclone track deviation along Andhra coast: GIS and remote sensing-based approach

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World-wide attention has been focussed on the need for better disaster mitigation programmes towards all the natural hazards. Tropical cyclone is one such natural hazard that needs better disaster management and prediction. GIS and remote sensing are two powerful tools for monitoring such disasters. Presented here is a case study where IRS-IC WIFS data coupled with historical database from Indian Meteorological Department is effectively used to demonstrate for better monitoring of tropical cyclone crossing the Andhra coast.

Bay of Bengal is one of the six regions in the world where severe tropical cyclones usually originate in the months of May, November, and December. They are well known for their extreme destructive potential and impact on human activities. Associated with the severe cyclones are strong winds, storm surges along the coast, and there is heavy rainfall which results in destruction to life and property. Proper prediction of this natural disaster requires understanding of its genesis, movement,
and landfall. Historical database of this tropical cyclone, available with Indian Meteorological Department (IMD), was used to understand its genesis and movement in a geographical information system (GIS) environment. This knowledge can be effectively used for proper prediction in real time mode. Remote sensing and GIS are two important tools for such type of disaster monitoring. IRS-1C satellite data from WiFS sensor covering ground swath of 810 by 810 km was effectively used to understand the regional geomorphology of the terrain.

Historically all the tropical cyclones crossing the east coast had their landfall near the major deltas like Ganges, Mahanadi, Godavari, Krishna, Penner, Palar, and Cauvery delta. Authors were interested to understand the behaviour of tropical cyclone’s landfall near the major deltas along the east coast. Limited studies have been undertaken world-wide regarding the influence of coastal morphology on the cyclone track movement. Most of the severe cyclones crossing Andhra coast (the present study area) had their landfall in Godavari, Krishna and Penner deltas. Very few severe cyclones had crossed Ongole coast. Vizag coast generally experiences storms and depression of lesser magnitude and intensity.

The objectives of the study are: (1) to understand the influence of coastal geomorphology for deviation of cyclone tracks crossing the Andhra coast, and (2) use of GIS in creating a historical database for better prediction of landfall of cyclone.

IRS-1C WiFS data dated 4 April 1996 was georeferenced to Survey of India toposheet covering the area. The total study area is bounded by 90° to 99°E long. and 7° to 24°N lat. The tracks of severe storms crossing the Andhra coast were extracted from the IMD Atlas. These were coregistered with the georeferenced satellite data for accurately overlaying the cyclone tracks on to the satellite image. For better management of the database, the severe cyclone storm tracks (wind speed = 47 knots) crossing the Andhra coast were classified as those which crossed the east Godavari, west Godavari, east Krishna, west Krishna, Ongole, and Nellore coasts. These were generated as separate vector files using Arc-Info GIS software. The tracks that had deviated without crossing the Andhra coast were vectorized as a separate layer (Figure 1). The total track width that covered the extremes of track between the north and south, crossing each of the above coasts was vectorized, and a separate file was generated for proper integration in the GIS. The georeferenced WiFS data was used to understand the regional coastal morphology of the study area. All the vector files generated in Arc-Info format were overlaid on the corrected satellite data (Figure 1) to interpret the relationship between cyclone movement and the local geomorphology.

Tropical cyclone crossing the Andhra coast generally originates between 5° and 7°N lat. belt in the intertropical convergence zones (ITCZ). Statistics of historical records have shown that the maximum number of severe storms crossing this coast originate in November, while second maxima is reached in May. The movement of the cyclone from its origin point to the landfall is dependent on the steering current. This in turn depends on climatological and environmental factors. One of the environmental factors is the physiography along the coast. The present study highlights the environmental influence on the movement of the cyclone track as it approaches the coast. Severe cyclone when it approaches the coast is influenced by the local pressure gradients related to the physiography of the coast. The isobars along the coast tend to be parallel to the shape of the coast.

The origin of severe cyclonic storms crossing east Godavari lies between 12° and 13°N lat. and 96° to 97°E long. (Figure 1). The tracks crossing west Godavari originate between 7° and 12°N lat. and 92° and 96°E long. (Figure 1). These two tracks after their origin show overlapping regions between 12° and 16°N lat. and 84° and 96°E long. From 84°E long. onwards towards the coast, the two tracks deviate independently and cross the coast. This deviation point is approximately 350 km away from the coast. Similar deviation of tracks are noticed for other severe cyclones crossing the Krishna, Nellore and Ongole coast (Figure 1). Most of the deviation of the tracks are seen as it approaches the coast within 100 km indicating probably the influence of local geomorphology for such preferential deviation (Figure 1). Most of the severe cyclones avoid the hilly Vizag coast and the interdeltaic areas along this coastal plain.

From the satellite data, Godavari delta shows arcuate shape with an areal extent around 4163 sq km, and its orientation is east–west with convex outline towards Bay of Bengal. Krishna delta on the other hand shows lobate shape with 4600 sq km area and is oriented north–south with convex outline towards the coast. The Penner delta near Nellore is cuspatate shaped with total surface area around 1470 sq km. The delta is oriented in the east–west direction with convex projection towards the coast. The Ongole coast shows concave outline. Most of the tracks approaching these zones have more or less maintained this trend and orientation of the delta. Notice the prominent east–west trend of tracks of Godavari, and north–south trend of tracks of Krishna (Figure 1). All the landfalls are near the major deltas and coastlines with a convex projection. The isobars show a tendency to be parallel to the shape of the coast, and the mesoscale meteorological lows and highs (pressure) depend on whether the coast is concave or convex shaped.

Probably in the present study area also the deviation of track might be related to the shape of the coast as
well as the orientation of these major deltas. The local pressure gradient generated too might be related to this shape. The absolute land temperature computation along this deltaic stretch during the landfall of cyclone may establish the reasons for such preferential pressure gradient along this stretch of the coasts\textsuperscript{10}, which is beyond the scope of present study. The other similarities observed in these areas are the extensive land use practices because of highly fertile soil, and the presence of huge water bodies like Godavari, Krishna and Pennar rivers, and Pulicat lake. The evapotranspiration from these water bodies and fertile soil perhaps provides the necessary conducive environment for a cyclone to approach this area (a cyclone requires unlimited source of water to maintain its strength and vigour)\textsuperscript{11}. Only two of the cyclone tracks were seen to cross this deviation zone, approximately within 100 km from the coast, and deviated further without crossing this coast during the last 100 years (Figure 1).

The entire database of historical tropical storm tracks and satellite data gridded to one degree interval (Figure 1) is useful for monitoring the cyclone tracks in real time mode. This database can be updated regularly when ever a new cyclone crosses the coast. All the meteorological parameters during pre- and post-cyclonic conditions can also be linked in the database for more precise prediction.

Predicting accurately the landfall of cyclone is a difficult task for any meteorologist. However, effective use of historical database is helpful for such type of prediction. In this study, GIS has been used as one of the powerful tools for such type of monitoring using the historical database. Also to understand the influence of local coastal geomorphology on the deviation of...
cycloone track just before crossing the coast is important for accurately predicting the landfall. Another powerful tool used is remote sensing to map the regional geomorphology of the terrain. The database generated can be updated regularly whenever a new cyclone develops and crosses the coast.

The study has revealed that accurate prediction can be made on the landfall of cyclone when the eye of the cyclone is within the range of 100 km from the coast. This is one step forward towards better disaster monitoring and management, even though the time required for taking disaster mitigation measures is less.


ACKNOWLEDGEMENTS. We acknowledge the technical advice and critical review by the Director, NRSA, Hyderabad. The technical suggestions of Dr S. K. Sasmal, Scientist, NRSA are duly acknowledged. The encouragement and support from colleagues of Geosciences Group are acknowledged.

Received 24 June 1998; revised accepted 24 August 1998

In vitro effects of adrenergic agonists and antagonists on tissue respiration in Rana limnocharis and Rana cyanophlyctis

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In vitro effects of α1- and β1-adrenergic agonists, phenylephrine (PHE) and isoproterenol (ISO), on the rate of tissue respiration of Rana limnocharis and Rana cyanophlyctis were studied in the presence and absence of α1- and β1-adrenergic antagonists, prazosin (PRAZ) and propranolol (PROP), during the month of April (summer/rainy season). PHE and ISO, when administered separately, induced significant increase in the rate of liver and muscle tissue respiration. ISO and PHE, when administered together, potentiated the calorigenic action of each other. PHE-induced increase in the respiratory rate was blocked significantly by PRAZ only in muscles of both the species. PROP blocked ISO-stimulated respiratory rate of liver tissue of Rana limnocharis and of skeletal muscle of Rana cyanophlyctis. However, PRAZ and PROP when administered together, completely blocked the ISO- or PHE-induced increase in the rate of tissue respiration in both the species. These findings seem to confirm that both α1- and β1-adrenergic receptors are actively involved in the adrenergic stimulation of the metabolic rate of amphibian tissues. The degree of involvement of the adrenergic receptors in calorigenesis seems to vary with the tissues and the species.

CATECHOLAMINE hormones, norepinephrine (NE) and epinephrine (EP), play a critical role in the regulation of the oxidative metabolism and calorigenesis in all groups of vertebrates except birds1-7. NE and EP have been reported to regulate the energy metabolism of mammals at low temperatures and during emergency.1,2 Similarly, due to their temperature-independent and rapid calorigenic action, these hormones act as emergency hormones for the regulation of the metabolic rate in poikilothermic vertebrates as well.5-11. NE and EP have been reported to stimulate respiration of brown adipose tissue in mammals, with the involvement of α1- as well as β1-adrenergic receptors12,13. Our recent studies indicate that as in mammals, catecholamines produce their calorigenic effects in amphibians as well through α1- and β1-adrenergic receptors9. However experiments, using specific α1- and β1-adrenergic agonists and antagonists, were needed to support our initial studies9-11. Therefore, we investigated in vitro effects of isoproterenol (ISO; a β1-adrenergic agonist) and phenylephrine (PHE; an α1-adrenergic agonist) in the absence and presence of prazosin (PRAZ; specific blocker of α1-adrenergic receptors) and propranolol (PROP; specific blocker of β1-adrenergic receptors) on the rate of tissue (liver and skeletal muscle) respiration in Rana limnocharis (a hibernating species) and Rana cyanophlyctis (a non-hibernating species).

All in vitro experiments were conducted on liver and muscle tissues collected from adult male Indian streaked frog, Rana limnocharis (a hibernating species; body weight 8-10 g; snout to vent length, 31-35 mm) and Indian skipper frog, Rana cyanophlyctis (a non-hibernating species; body weight, 10-12 g; snout to vent length, 35-40 mm). These two species of frog are commonly found in and around Shillong (lat. 25°30'N; long. 91°52'E; alt. 1450 m above sea level; minimum temperature, 2°-4°C; maximum temperature, 25°-28°C). Frogs were collected locally during the month of April (maximum temperature 23°C; minimum temperature