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Fisheries and Weather

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The importance of weather in our daily life is well known. It is a common experience to us that the early setting in of the monsoon or a late monsoon or its failure affect our agricultural production, some times with disastrous consequences. Similarly life in the sea also is dependent on the various elements of weather like temperature, wind, duration of sun shine etc., either directly or indirectly. Indeed there is practically no business in our daily life which does not depend to a greater or a smaller extent on weather, but there is scarcely any other profession which is dependent to such a high degree on weather as that of fishermen.

The currents and the distribution of various hydrographic features in the oceans represent a dynamic equalibrium between the sea and the atmospheric conditions. Part of the energy which drives the ocean currents and generates waves at the sea surface is derived from the winds; another part of the energy is transmitted to the ocean by radiational processes which are modified by atmospheric conditions. But the winds and the atmospheric conditions themselves depend on the distribution of physical properties in the ocean. Therefore the oceanic circulation and the atmospheric circulation are closely linked. The supply of energy from the ocean to the atmosphere is localised in some parts of the world by the nature of the currents; in these parts the sea exerts a profound influence on the climate and weather. The warm Gulf Stream in the west and the Kuroshio Current in the east may be cited as examples; but for these the life would have been in a different way in the British Isles and in the Japanese Islands because of the intense cold that would envelop these regions.

The marine meteorological features around India are more fascinating by virtue of the uniqueness of the ideal monsoon non-existent elsewhere in the world. The rythmic nature of climatic changes in this area reflect on the fish catch in a similar manner to their variation.

Effect of weather on production

Solar radiation, the source of energy for ecological cycle in the sea, varies daily, seasonally and geographically. The total energy impinging upon the sea surface and available for photosynthesis is a function of the intensity and the length of daylight as modified by the average cloudiness of the particular area being considered. The insolation and the replenishment of nutrients are principal determinants of the biomas which may be produced in any oceanic environment. The species composition of population is certainly dependent upon energy and nutrient supply, but may also be modified by the

characteristics of environment. The supply of nutrients in turn again depends on the atmospheric circulation.

When steady winds blow parallel to the coast with the coast line on the left hand side of the wind flow in the northern hemisphere the surface waters are transported away from the coast and the subsurface waters that are rich in nutrients are moved up. This phenomenon known as upwelling is an important process for refertilizing the impoverished surface layers. Such a process is occurring on both the coasts of India seasonally due to steady monsoon winds. A detailed study of the upwelling off the West Coast of India has been undertaken at the Central Marine Fisheries Research Institute and this has shown that upwelling starts at subsurface depths by the end of February and the upwelled water reaches the surface by May. The cessation of upwelling varies from south to north and it takes place by July in the south and by August in the north. The process of upwelling occurs in the open oceans also when two water masses diverge as in the equatorial regions.

In contrast to these dynamical situations which are comparatively rare in the oceans as a whole, there is also static system in which the surface waters are enriched by winter mixing known as thermal mixing. During winter, in the temperate and northern regions, surface waters cool sufficiently to destroy the summer thermocline which acts as a barrier for vertical mixing and the water becomes mixed even below the euphotic zone. Not only are the nutrients from below the euphotic zone brought up and mixed with the surface layers, but the plankton algae are transported downward and spend some of their time in darkness. As a result, though nutrients are plentiful, production is severely curtailed due to limitation of light. With return of spring, the surface waters begin to warm up, a seasonal thermocline develops and the euphotic zone becomes stabilized against vertical mixing. At the same time radiation increases. Those phytoplankton which find themselves in the euphotic zone are held there and suddenly have access to both light and nutrients. The stage is set for spring bloom, a feature characteristic of the temperate oceans.

Influence of weather on fish availability and migration

As meteorological factors are main causes for changes in hydrographical conditions in the sea an indirect correlation between the behaviour of the fish and meteorological factors can often be found although mostly direct causative factors are to be sought in hydrographical parameters.

The surface temperature in the sea is dependent on the amount of insolation and its daily and seasonal variations and on the cloudiness. It is also affected by evaporation which is a function of wind speed and humidity of air. A part of heat exchange between sea and atmosphere is caused by convective transfer of heat which in turn is a function of sea air temperature and wind speed.

A low water temperature can considerably delay spawning or displace spawning area, so that the development of eggs and larvae is changed in time and space. This may result in low survival because the larvae grow up in areas where the environmental conditions, including the availability of food for them are likely to be unfavourable.

Storms have great influence on the occurrence and migration of fish and they are some of the limiting factors in shore–ward movement of many fish. Some species of fish not normally found in shallow exposed waters, may become established in such habitats during the period of calm weather. Hence maximum catches are expected one to two days before and after the passage of cyclones possibly as a result of turbulence.

The passage of storms or persistence of onshore winds results in turbulent conditions and the fish are killed apparently due to erosion of gill filaments by accumulation of sediments. The persistence of the particular type of condition may at times give rise to mass mortality of the fish and this may be one of the reasons for such mortalities in the Arabian Sea. The mass mortality can also take place when there is a sudden fall of surface temperature due to strong upwelling. For example a sudden fall of surface temperature by 15°C due to intense upwelling seems to be responsible for the mass mortality recently reported by R. R. S. *DISCOVERY* on Somali coast. Further the mass mortality may also be the result of shifting of the level of oxygen minimum layer due to meteorological factors.

Present and future plans of study for forecasting fish catch

Long period trends in climate and hydrography affect the distribution and abundance of all species, whether they are fished or not; and they affect different species in different ways. There is a continuous change in numerical interrelations among many species inhabiting an environment, perhaps, with some pattern of oscillations. Thus the weather not only helps to determine the size of the fish stock but also their seasonal, daily and hourly behaviour, availability and vulnerability of fishing and hence the relatively great variation in catch. And so the weather conditions during a particular fishing season for a given species can be compared with the average climatic conditions during that seasonal period for many years and on this basis the weather can be classified as favourable or unfavourable from fisheries point of view.

It is some times more apt to analyse the direct influence of a single environmental factor on fish behaviour and availability and relate these by physical cause and effect to meteorological factor. One of the most easily measured and observed environmental factor is sea temperature which influences the migration of economically important stocks. The investigations on temperature anomaly that are being carried out at the Central Marine Fisheries Research Institute are expected to give a fair picture for forecasting the fluctuations in fish catch.

For the area around India, the controlling weather factor is mainly the South West Monsoon and so a study of the variation in sardine fish catch with the intensity of the South West Monsoon has been taken up by the staff of this Institute. The average pressure gradients along the west and east coasts of India are considered as the indices of the monsoon intensity on both the coasts and the changes in the annual pressure gradients are correlated with the sardine fish catch. The results indicate a decrease of fish catch with the increase of intensity of monsoon upto a certain optimum pressure gradient and beyond this the increase of fish catch is accompanied with the intensity of monsoon. Apparently the

decrease of fish catch is due to the decrease in upwelling in the area when the onshore monsoon winds oppose the process of upwelling. But this effect is masked beyond the optimum value as wind mixing, perhaps, plays a major role.

The monthly or seasonal anomaly of barometric pressure is sometimes a suitable parameter for the interpretation of the causes of fluctuations in fish catch. The pressure anomalies that are the deviations from the normal distributions of air pressure for that particular period, indicating the anomaly winds, acts upon surface currents and their boundaries and thereby influence the direction of cold or warm water in an anomalous way.

Conclusion

The operations of even the large fishing vessels are so much determined by the weather conditions, that the catches and landings depend greatly on the frequency of cyclones during the main fishing season. Almost all kinds of fishing gear are adversely affected by waves and currents in the sea. Hence apart from the knowledge of the weather conditions helping in gaining an understanding of the behaviour and distribution of fisheries resources, weather forecasts should help Indian fishermen who are forced to keep in port during the major part of the South-West Monsoon because of heavy seas. However, even at the height of the monsoon, lulls occur lasting a week or more during which a temporary resumption of large scale fishing would be feasible. Since fish are more plentiful in summer than in winter at least over the Arabian Sea, the advantage to the fishermen from the improved short range forecasts is obvious.

The experience of some of the European countries, America and Japan speaks of the importance of the establishment of a good and a reliable weather service for economical fishing and it is needless to emphasise the necessity for such a service in the Indian waters. Observation platforms such as anchored buoys in a close net work might most appropriately and profitably be located in the Indian Seas thus making it possible to obtain truly synoptic data on oceanographic and meteorological conditions in the mid-oceans. Although such a study would involve heavy expenditure, the effort would be worthwhile in view of the fruitful results that it would lead to in the fields of fisheries, meteorology and naval operations.