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APPLICATION OF REMOTE SENSING TO MARINE FISHERIES: ALTERNATIVE APPROACHES

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INTRODUCTION

The concept of remote sensing in marine fishery exploration is nothing new to the professional fisherman, who has always tried to locate the shoals from a vantage point in the fishing craft. Since the birth of organised fishery, crow's nest or any high position in the vessel is used for visualising the density and type of fish, suggesting that perception from heights is more synoptic in comparision to proximal viewing. A technological refinement of this principle over time, has lead to the systematic evolution of remote sensing.

The earlier efforts to locate fish in the sea from height were, naturally, made from hot air balloons and aircraft (Squire 1982: Laurs & Brucks, 1985). But, it did not take long to realise the problems of logistics and expensive operation associated with the said efforts, which at times, looked uneconomical. Morever, certain conceptual understandings like the one suggesting that variations in ocean conditions played a key role in natural fluctuation of fish stocks (Hela & Laevastu, 1961; 1970) made it think that it is not always necessary to attempt to detect the fish directly. Accordingly, the remote sensing efforts shifted from locating fish shoals to making suitable oceanographic measurements (Pearcy, 1973; Thomas, 1981) and locating favourable areas (Squire, 1961; 1972) with the help of satellites. A number of experiments followed, among which, the notable ones are the ERTS-1 menhaden experiment (Kemmerer et al., 1974), Skylab game fish investigation (Savastano et al., 1974) and Landsat menhaden and thread herring investigation (Brucks et al., 1977. While none of these efforts have attained operational status,

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it still appears optimistic for us to arrive at an operational approach with remote sensing, in the light of conceptual soundness of satellite sensor applicability.

CONCEPTUAL BACKGROUND

All different remote sensing applications to fisheries, however contrasting they may appear in details, are based on the strength of synopticity that is obtainable in satellite data. As seen in Fig.1, the oceanographic features and processes are bound by

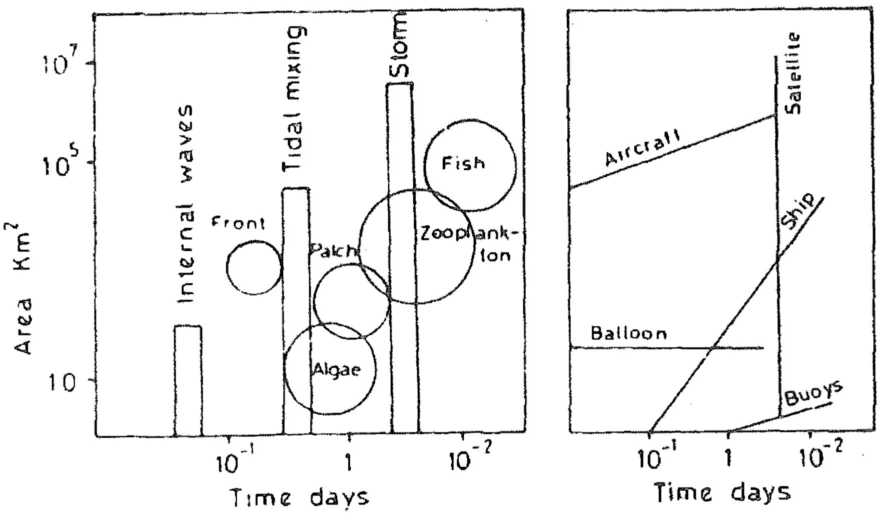

Fig. 1 Schematic of space - time domains of marine parameters and sampling platforms.

the definitive nature of space-time continuum and a comprehensive sampling of them is only possible when a relative time freezing is simulated over large space (Sudarshana, 1987; Sudarshana et al., 1988). Delivering this effect is the uniqueness of remote sensing and thus the remotely sensed data enables us to decipher information which is totalistic. While dealing with an ecological production of the type of fish, which is immensely influenced by the intricate mechanism of oceanogrpahic processes, a totalistic approach is indispensible.

As a result, the diverse remote sensing efforts in explaining marine fish resources have sought to explain the ocean conditions in a broad perspective, as a first step. This is normally followed by the development of schematic, mathematical or deterministic models which interrelate the ecodynamics and trophic production. Finally, a relationship between the satellite sensor response and the resource abundance is attempted to be established. However, validation of the results has always posed a challenge to our interpretability as it is very difficult to organise a field data collection that can match the synopticity of satellites. It is also a difficult proposition to transfer the synoptic data to the ultimate user in the near real time, so that he may be appropriately equipped to exploit the situation. In any case, all these are not absolute constraints and dedicated efforts in future might outdo the limitations they pose to contemporary researchers.

TEMPERATURE APPROACH

Measurement of temperature from satellite sensors is one of the near operational activities, world over. Many sensors like Seasat Multifrequency Microwave Radiometer (SMMR) and Advanced Very High Resolution Radiometer (AVHRR) have been flown on board satellites in the past, which have continuously and repetitively recorded temperature of land and ocean surfaces. Additionally, thermal infrared band has also been often included in operational satellites.

The measured Sea Surface Temperature (SST) helps in identifying temperature regime, thermal fronts and upwelling zones, while it is also possible to interpret the data to obtain surface ocean circulation pattern. As the poikilothermic piscine species are controlled by temperature profile of ocean waters, it is likely that the synoptic SST information is highly correlatable with attributes of their life cycle. Using this fact, Lasker (1978), Lasker *et al.* 1981), Parrish and Maccall (1978) and Fiedler (1983) have described the spawning grounds of certain species in the temperature regimes of ocean waters. The delineation of thermal fronts and upwelling zones also help in charting the high productive zones, as shown in the works of Laurs *et al.* (1981), Roeffer et al (1982), Laurs *et al.* (1984) and Laurs & Austin (1985).

On the other hand, the models describing circulation, as a result of the surficial differential temperature, may also be used to understand the transport of larvae and pelagic resources (Carey and Robinson, 1981; Leming, 1981; Brucks *et al.*, 1984; Laurs & Austin, 1985). Fig.2 gives a schematic representation of the various possibilities through temperature measurments

WIND STRESS APPROACH

Measurement of wind stress of the ocean surface is possible with the help of a specialised satellite sensor like scatterometer which works on the principle of microwave back-scattering. However, it is very unfortunate that SEASAT, which carried a scatterometer on board, went out of operation within hundred days of its launching in 1978. The next available scatterometer would be on-board ERS-1, which is proposed to be launched during 1990.

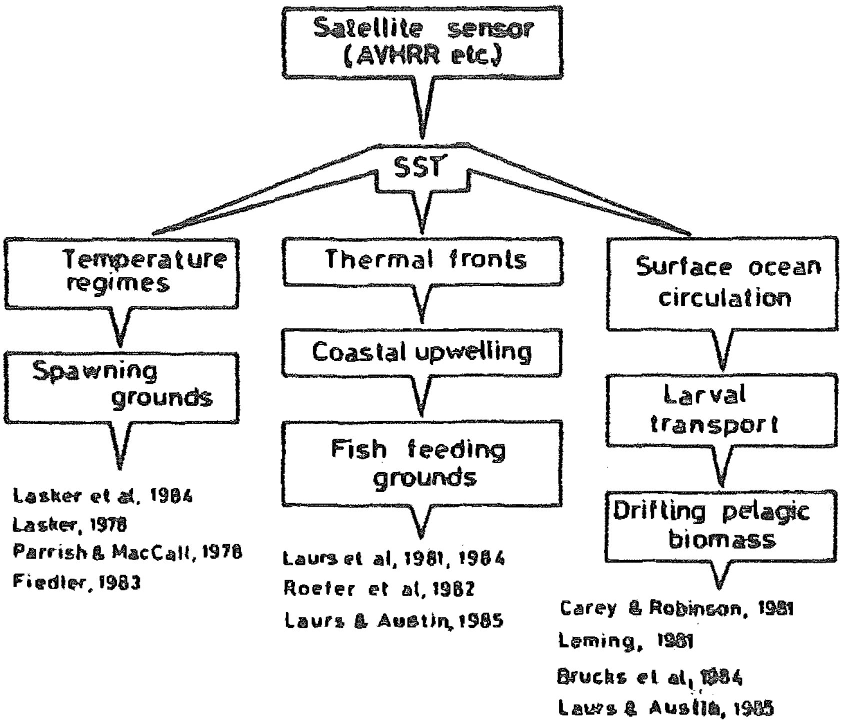

Fig. 2 Schematic representation of fisheries investigation based on SST measurement from satellites.

The wind stress measurements made by scatterometer lead to the development of numerical circulation models and knowledge on geostrophic currents. In other words, they lead to the understanding of ocean surface circulation and vertical movement of water. Burcks et al.(1984) made use of this information and described the patterns of larval transport in water and identified enrichment zones of spawn material. A schematic representation of this approach is shown in Fig.3.

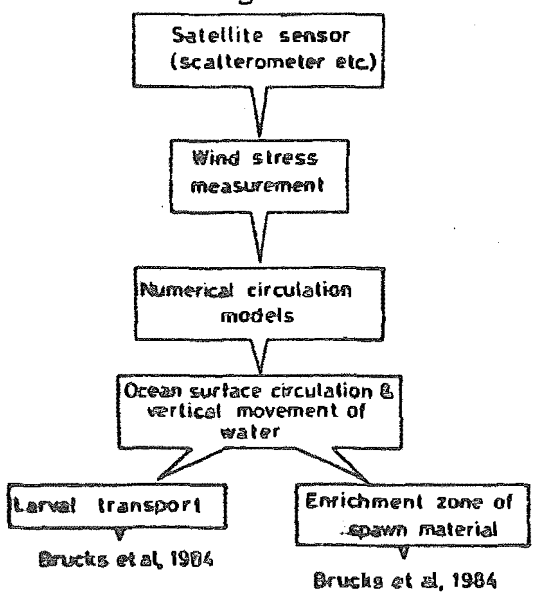

Fig. 3 Schematic representation of fisheres investigation based on wind measurements from satellites.

However, this approach is not a widely attempted one, mainly due to the unavailability of suitable satellite data. Perhaps, it would set an impetus with the inception of ERS-1 and other microwave satellites that are planned for the next decade.

OCEAN COLOUR APPROACH

Studies on ocean colour have been made widely in innumerable coastal and marine environments, thanks to the opportunities provided by Coastal Zone Colour Scanner (CZCS), Thematic Mapper (TM), Multi Spectral Scanner (MSS) and Ocean Colour Experiment (OCE). The ocean colour studies have mainly concentrated on estimating various pigments, evaluating pollutants, delineating turbidity and deciphering hydrographic characters of water. The opportunities in the past have been wide ranging and the planned launching of Seaviewing Wide Field-of-view Sensor (SeaWiFS) on Landsat-6 during 1989-90 has kept the hopes promising.

The pigment estimation efforts have often lead to understanding the primary production in synoptic levels, which in turn infer on trophic energy budget. While calculating the trophic energy budget is more of an academic exercise, Kemmerer *et al.*(1974), Cram (1979), Fiedler (1983), Shannon *et al.*(1983), Laurs *et al.*(1984) and Narain et al (1985) have used the pigment data in characterising fishing zones.

Another approach from ocean colour sensor bands has been experimented by Sudarshana (1986) and Sudarshana *et al.*(1988). In this study, the time series data has been utilised in obtaining models that can interrelate physico-chemical parameters and spectral data. With an extrapolation of the results to a part of the Arabian Sea coastline, fish resource habitats have been evaluated.

Alternatively, the ocean colour measurements would be helpful in mapping turbidity and classifying pollutants in marine waters. Such attempts would also be helpful in fisheries research as they would indicate zones of doubtful life-support.

The opportunities of ocean colour measurements are schematically sketched in Fig.4.

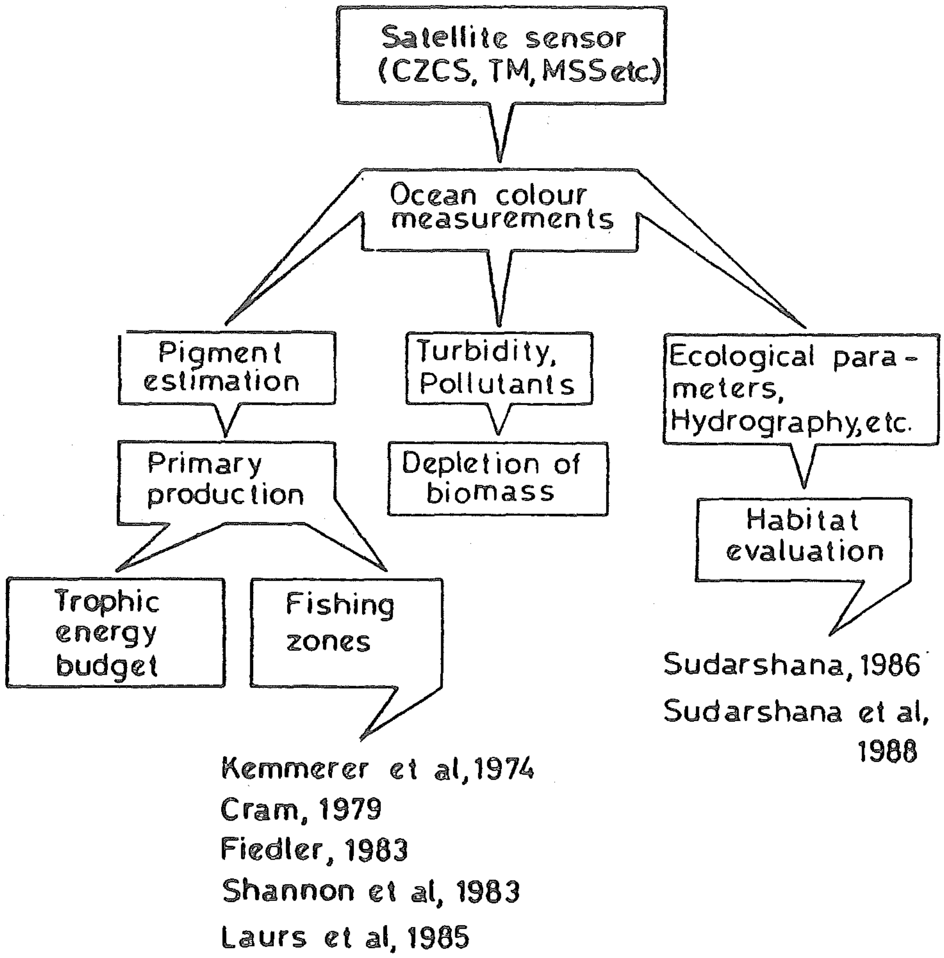

Fig. 4 Schematic representation of fisheries investigations based on ocean colour measurements from satellites.

CONCLUSION

In all, the application potential of remotely sensed data to marine fish resource investigations is promising, but the operationalisation of any particular technique is not immediate. The various pathways that are being experimented have to establish in the light of severe challenges with respect to reliability standards. Perhaps, the approaches are to evolve so as to involve several satellite sensors that give information on various oceanographic features. Such an integrated approach is desirable as the living resources in the sea are subjected to multiple factor control. Inspite of all these, the transfer of useful data to the fisherman, in real time, is still a problem area as most of our fishing vessels in Indian waters are not approachable by radio net-work. Therefore, only sustained alround efforts can make useful contributions in the field of remote sensing for marine fisheries, in the eve of an impeding new era.

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