IMPORTANCE OF METEOROLOGICAL AND CLIMATOLOGICAL INFORMATION FOR FISHERIES

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INTRODUCTION
Fishery production is strongly related to meteorological and climatological conditions.

Being aware of weather and climate is essential to fishery enterprises management at different levels:
- Design (determines the characteristics and most steady aspects of the production system)
- Planning (to establish objectives and programs for one or more years)
- Handling (circumstantial and operational decisions)

An increasing use and availability of weather and climate information, supported by telecommunications and the media, year after year they are being innovated, allowing users to have a detailed and opportune information.

The following aspects are developed:
- Definitions and concepts related to fishery
- Effects of climate variability on fishery
- Effects of climate change on fishery

Beneficios de los Pronósticos del ENOS para la Agricultura y las Pesquerías
- Agricultura en los EUA: $200 - $300 millones/año
- Agricultura México: $10 - $25 millones/año
- Agricultura mundial: $450 to $550 millones/año
- Almacenamiento de maíz EUA: $200 millones/año
- Almacenamiento de arroz mundial: $23 billones/año
- Pesca Salmón NW EUA: $1 millón/año

VARIABLES OF OBSERVATION

• Observations and on site measurements of environment, ocean and air variables, represent difficulties because it is not easy to find normal and representative conditions to make the observations.

• The effect of vessels movement and its influence on air temperature, wind, precipitation and humidity, makes it difficult to choose the ideal place for the observation and the method to be used.

• Indirect measurements by means of sensors located in artificial satellites and buoys, have helped to have a global coverage of all the marine areas in the world, contributing not only to the meteorological knowledge in the field of the ocean, but in the different sciences as marine biology, oceanography and physics (ocean’s color and light) among others.

WMO
World Observation System

11,000 surface stations, 1,000 high-altitude stations, 3000 information relieve stations on aircrafts. (130000 observations), more than 7,000 volunteer observation ships, polar orbit satellites, geostationary satellites, 700 buoys, meteorological radars.
General measurements of meteorological elements taken at meteorological stations situated in land are:

- Current weather
- Past time
- Wind direction and speed
- Cloudiness
- Type of clouds
- Visibility
- Temperature
- Humidity
- Atmospheric pressure
- Atmospheric pressure trend

Oceanic variables such as:
- Sea Surface temperature
- Wind direction and speed
- Wave movement direction
- Wave period
- Waves height
UTILITY OF METEOMARINE VARIABLES
Operationally, short term forecasts:

Help users (sailers, fishermen etc) of ships, of different sizes, to make decision at open sea

Help to avoid adversities such as:

- Passage of frontal systems
- Tropical waves
- Hurricanes
- Strong winds associated to gusts
- Rainfall with lightning
- The marine component: rough sea, high waves, and swell, among others
Fishing fleets are especially interested in having available sea surface temperature, because:

- It helps them to find fish shoals, if they know this variable.
- It helps to make conclusions about other physical, chemical and biological processes related to the ocean.

For example a very close relation between:
- ✓ Sea surface temperature, salinity and density of sea surface
- ✓ Sea surface temperatures (SST) and the biological activity

Through sea surface temperature (SST) it is possible to monitor the processes of ocean-atmosphere interaction as the evaporation and energy flux that take part in climate.
Meteorological marine measurements may help to solve three problems.

• Open sea vessel operations
• Studies on climate (for example: El Niño / La Niña phenomena).
• Explanation to climate change and global change.
• Identification of socio-economic and environmental potential of coastal regions.
Use of meteorological information to determine fishing zones
EFFECTS OF EL NIÑO PHENOMENON ON FISHERIES
El Niño, meteorological phenomenon also called ENSO (El Niño Southern Oscillation”), is a change in the ocean-atmosphere systems occurring in the east Pacific, that contributes to significant climate changes, and causes damages at a global scales, affecting South America, Indonesia and Australia.

El Niño phenomenon alters:

• Atmospheric pressure in different regions
• Changes wind direction and speed
• Rainfall displacement to tropical regions
• Increase of Sea Surface temperature
• Thermocline descent which entails important consequences on marine life
The thermal anomaly of sea surface alters the usual climate of the affected regions (coast of South America, especially Colombia, Ecuador and Peru, Pacific archipelago as the Galapagos).

These temperature changes have a repercussion on water salinity, resulting in changes in environmental conditions of the marine ecosystems. This affects fish populations and consequently also affects fishing activity, especially the ones in the south Pacific.
THE EFFECTS AND IMPACTS OF EL NIÑO

The East Pacific region
The South American west coast is one of the main regions of ascending currents in the world, in which 12% to 20% of the total world capture is made. In this zone, before the occurrence of El Niño 1972-72, the Peruvian Anchoveta was the major capture, reaching annual maximum values of 12 million tons, it reached its lowest historical level when the El Niño 1982-83 occurred.

In other parts of the world
Fish populations outside the east Pacific area are affected through atmospheric teleconnections; however, as the distance from the Pacific area grows farther, the links are less clear; therefore, it is more difficult to separate the effectos of El Niño from the ones related to fishing.
UNLOAD OF MAIN PELAGIC RESOURCES
(1950 – 2007)

Millones de toneladas

Anchoveta
Sardina
Jurel
Caballa
COLOMBIA
In the case of fishing, due to the increase of sea surface temperature in the Pacific coast of Colombia, fishing activities suffered important reduction in the amount of capture.

The mangroves were affected as the levels of wetlands were reduced and the content of salinity increased, and the coral formations in certain zones suffered a lixiviation.

There is also migration of species that traditionally are present in this time of the year in the region, and also the immigration

Concerning the continental fishing, the population of “bocachico” (prochilodus magdalenae) is affected when the water levels of the rivers descend due to the presence of El Niño event.

CHILE
The increase of sea surface temperature cause important alterations in the distribution of pelagic (fish) resources in the northern and central zones of Chile. Although this area benefits from this event during its initial stage, when there is mass migration of fish from the Peruvian coasts, in average, the impact is negative.

Likewise, the increase of winter storms in the central region of the country, contributes to limit the periods of fishing activities.
ECUADOR

Sea and continental fishing were affected, one of the effects was the alteration of the marine habitat, that changed the phytoplankton and zooplankton in their composition as well as in the production, influencing this way, the food chain, causing migration of species to more adequate latitudes for their development and it also affected the basic biological process of reproduction which results in a less concentration of eggs and larva.

As consequence of the diminish of natural food many guano birds, seals, penguins, etc. either died or migrated to other latitudes, reducing this way the positive impact they provide to the ecosystem.

But there were also positive effects such as the case of the increase of shrimp larva, also some crustacean species approached the coasts allowing their growing and production in large amounts.

Fishermen had the opportunity of a prolonged capture period of prawn, it is estimated that total damage in the fishing sector due to El Niño 97-98 amounted to 42,4 million dollars including the direct damages as well as the indirect ones.
El Niño phenomenon generates great impacts on Peruvian fishing activities, on the one side it modifies the marine ecosystems and on the other it influences the increase of watercourses.

The considerable increase of sea surface temperature caused the migration of the “anchoveta” and sardine, used in the elaboration of fish flour, to the north part of Chile.

The increase of rainfall in the mountain region and part of the coast increase in the volume of water of the rivers that flow into the Pacific, this together with the strong swell, destroyed the production infrastructure of prawn located near the coast.

Marine fishery most affected by El Niño, was the industry that provided the raw material to the four and oil fish industry and canned food industry. Exportations of the fishery sector decreased, consequently there was a decrease in the source of foreign currency.

Continent aquaculture was affected due to the diminish of trout production, as a consequence of river floodings, since they are the production areas of trout eggs and alevin, that supply the demand of private, community and family aquacultures, for the regional and local consumption.
<table>
<thead>
<tr>
<th>Category</th>
<th>Fish</th>
<th>Invertebrates</th>
<th>Algae</th>
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<tbody>
<tr>
<td><strong>Pelagic</strong></td>
<td>Perico, Samasa, Jurel, Caballa, Atun</td>
<td>Concha de Abanico, Percebes, Langostino, Pulpo</td>
<td>Ulva lactuca</td>
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<tr>
<td><strong>Demersal</strong></td>
<td>Merluza, Falso Volador, Tollo</td>
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<tr>
<td><strong>Coastal</strong></td>
<td>Lisa, Cojnova, Lorna, Chita</td>
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<td>Caracol, Concha de Abanico, Percebes, Langostino, Pulpo</td>
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<tr>
<td><strong>Algae</strong></td>
<td>Ulva lactuca</td>
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<tr>
<td>El NIÑO</td>
<td>Affected species</td>
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<tr>
<td><strong>Pelagic</strong></td>
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<td>ANCHOVETA</td>
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<td>MACHETE</td>
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<td><strong>Invertebrate</strong></td>
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<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>ALGAS PARDAS</td>
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<td><img src="https://via.placeholder.com/150" alt="Image" /></td>
<td>Lessonia sp. Macrocystis</td>
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**NORMAL CONDITIONS**

**AUTUMM**

"Anchoveta"
Catg. Concentración
- < 10000
- 10000 - 20000
- 20000 - 40000
- > 40001 t.

**Otoño 2000**

**EL NIÑO CONDITIONS**

**AUTUMM**

"Anchoveta"
Catg. Concentración
- < 10000
- 10000 - 20000
- 20000 - 40000
- > 40001 t.

**Otoño 1997**
EFFECTS OF CLIMATE CHANGE ON FISHERIES
The consequences of change in the biological productivity of marine ecosystems on fishery will be different one from the other and will depend on specific environmental changes that will occur and on the biological characteristics of each specie.

Climate change also entails changes in the distribution area of marine resources. It is very likely that they move to the North or South Pole, or to the nearest one.

The consequences of climate change on fishery will affect one sector of most economies, which is characterized by the full use of resources, excess of capacity and conflicts among fishermen, and conflicts with other groups, that propose alternative uses of marine ecosystems.

The United Nations Environmental Program (UNEP) points out that the increase of sea surface temperature in next decades may cause the death of 80% of the coral reefs in the planet. Another threat is that the increment of carbon dioxide emissions will increase the acidity of the ocean.
THREATS

Marine warming:
- Increase of almost 1,5º C in sea surface temperature since the 1960.
- Warming down to 3,000 m depth

Sea surface waters acidifications, with a diminishment in ocean pH of 8,2 to 8,1 in the last 50 years due to a greater content of CO2.

Increase of mean sea level:
- Increase of 19,5 cm since 1870
- Coasts retreat and threat pose to wetlands and coastal zones.

Increase of extreme meteorological events.

Alteration of the morphology of coastal erosion and flooding

Salinization of low lands.
**IMPACTS**

**Displacement of species**
- Modification of the species natural habitats
- Displacement of the species distribution areas
- Diminish of marine biodiversity

**Multiple effects**
- Increase of eutrophication
- Coral whitening
- Mangrove deterioration

**Combination of pressures on marine environment**
- Contamination
- Fishing overexploitation
- Uncontrolled increase of urban/residential areas
MEASUREMENTS TO BE TAKEN TO MITIGATE THE IMPACTS

• Integrated management of coastal zones, and monitoring and protection plans, which are not specifically planned in terms of variability and climate change and are not completely implemented.
• Official regulations concerning access to fishing areas.
• New regulations to control the use of coast and fishery resources.
• Full observation of International Agreements for the protection of marine environment, the prevention of contamination and commercial fishing management.

OPPORTUNITIES TO FACE THE CHALLENGES

- Adaptation
- Mitigation
- Innovation
- Regulations
- Proposals
CONCLUSIONS AND RECOMMENDATIONS
The fishery has a high dependence on weather and oceanographic because variation in temperature and salinity marine produces changes in the normal habitat, which promotes migration of species catch normal and the immigration of new species.

Knowledge of weather and climate are essential for different levels of management of fishing enterprises: Designing, Planning and Management.

Opera, weather forecasts in the short term, help users (sailors, fishing, etc.) from boats, of varying size, to make decisions on the high seas.

The indirect measurement through remote sensors located in artificial satellites and buoys, have helped to cover comprehensively in all areas of maritime world.

A fishing fleets were particularly interested to have information on sea surface temperature because they sometimes seek stocks with the knowledge of this variable.
The El Niño directly and indirectly affects the entire planet, while Ecuadorians, Peruvians and Chileans drown in intense rainfall and high temperatures, Australians and Indonesians yearn for these rains are exposed to intense droughts and dust storms, affecting all productive sectors.

Consideration should be given much more impact that causes El Niño in the fishery for different countries to prevent situations adverse to the economy.

Need to establish a baseline to measure the effects of climate change on coastal marine biodiversity. It is necessary to promote research on the various ecosystems and marine species, as well as establishing synergies of collaboration between different actors.

We should conduct studies to quantify the impact of regional and global changes induced by natural and human activities at sea and long-term trends in marine ecosystems.