

Proposal for a joint SCOR Working Group to Investigate Physical and Biochemical Classification of the coastal estuaries in the southeastern Pacific to be applied on Integrated Management of Coastal Areas

Submitted by National SCOR Committee (Ecuador)

Abstract

Estuaries are among the most biologically productive ecosystems on the planet. These ecosystems provide important ecological functions and are a significant source of food. These dynamic bodies of water also have economic importance for their countries and the people that live near them.

The research projects that focus their efforts in the understanding of physical and biochemical processes and properties of the coastal estuaries classification are very useful to the community. This information allows the researchers to know how the quality of the water is determined by the processes that take place in the estuaries and how they are influenced by the effects of the nature and human activities. It also let us understand how water circulation and mixture processes (Physical Processes) in an estuary originate changes in nutrients and biological distribution (Biogeochemical Process), which is directly related with the abundance or shortage of estuarine biodiversity.

The proposed working group will center their attention on Physical and Biogeochemical processes in order to classify the coastal estuaries. The group's work will be conducted over a period of two years in order to reach the following objectives: (1) Identify the main estuaries in southeastern Pacific coast which are going to be analyzed, based on their extension and their biodiversity. (2) Analyze the physical and biochemical processes that take place in the estuaries and establish a classification on those bases. (3) Based on this classification, suggest integrated management programs that might be appropriate for each kind of estuary. (4) Establish and maintain a Web site as a "virtual workshop" that can be used by the estuarine research community to exchange and discuss ideas, results, and future planning. (5) Generate a final report that documents the results and the methods used by the working group.

Rationale

Estuaries are important for many reasons. Estuaries are among the most biologically productive ecosystems on the planet. These ecosystems also provide many other important ecological functions; they act as filters for terrestrial pollutants and provide protection from flooding. Estuaries also have economic importance. These dynamic bodies of water provide us with an important source of food.

Circulation and mixture processes (Physical Processes) in an estuary originate changes in nutrients and biological distribution (Biogeochemical Process), which are directly related on estuarine biodiversity. Another event that might affects biogeochemical and physical impacts in estuaries is El Niño, which is the main climate fluctuation in the southeast Pacific.

We have seen over the years that the impacts of these problems are quite visible. Pathogens have led to a large number of shellfish bed closures. Over-enrichment of nutrients is contributing to decreased dissolved oxygen levels and loss of seagrasses. Introduction of invasive species is adversely affecting native species and their habitats.

Individual scientists from countries in the region will form a working group. It will seek input from the agencies and institutions responsible for research and managing the resources of the estuaries, as well as members of the community-citizens, business leaders, educators, and researchers in each country.

The research project will focus on the investigation and understanding of physical and biogeochemical processes (or properties) of the coastal estuaries and their classification. This study will develop a regional classification of southeast Pacific estuaries based on easily quantifiable biogeochemical and important physical characteristics. A Southeast Pacific Estuarine Database will be compiled incorporating spatial, geographic, morphological, biological, chemical and climatic data for Southeast Pacific coastal estuaries.

The working group will provide a methodology by which important physical biologically and geochemical factors will be identified. This group would provide scientific information that would be useful to identify, restore, and protect significant estuaries of the southeast Pacific coast. It will focus not just on improving water quality in an estuary, but on maintaining the integrity of the whole system and its biochemical and physical properties. The activity will provide information important for learning how we can safeguard these irreplaceable resources. This information will allow the researchers to know how the quality of the water is determined by the processes that take place in the estuaries and how they are influenced by the effects of the nature and human activities.

The Land-Ocean Interactions in the Coastal Zone (LOICZ) project has demonstrated the practicality and usefulness of classifying coastal areas according to their common features, in the LOICZ coastal typology activity. This working group would seek cooperation from LOICZ in its work.

Scientific Background

Although each estuarie is unique, they all face similar environmental problems and challenges, such as: overenrichment of nutrients, pathogen contamination, toxic chemicals, alteration of freshwater inflow, loss of habitat, declines in fish and

wildlife, and introduction of invasive species. These problems tend to cause declines in water quality, living resources, and overall ecosystem health.

Many studies have been conducted about South American coastal estuaries, but no one of the studies has been based in the Physical and Biogeochemical Classification. For many years the estuarine environments like Sudeastern Pacific estuaries, have been studied considering changes that occurred on spatial scales of hundreds of meters and temporal scales of minutes, variations result from the interaction among lateral bathymetric changes, tidally driven flow, gravitational circulation and wind-driven flow. It also has been recognized that the longitudinal flow in estuaries, originally described by Pritchard (1954) and Hansen and Rattray (1965), has a robust lateral structure caused in part by bathymetric changes and density differences between shoals and channels Huzzey and Brubaker 1988; Wong 1994.

Others studies have suggested that the spatial gradients associated with the lateral structure of the longitudinal flow may be important contributors to the estuarine momentum balance.

A work about Australian estuaries indicates that in the extreme variation in river flow means that most Australian estuaries are characterized by distinctive wet and dry season mixing regimes. Well-mixed estuaries on the East Coast are subject to large flood events which completely flush the estuary and commonly push a freshwater plume into coastal waters (Davies and Kalish, 1994; Eyre, 1994; Eyre & Twigg, 1997). As freshwater flow decreases a salt wedge develops followed by a return to well mixed saline conditions. In the drowned river estuaries of the central NSW coast, short lived, high freshwater flows can form an overlying surface layer with minimal salt wedge development. Mixing at this layer is minimal because it is unaffected by tidal turbulence (Wolanski, 1977).

Many authors have worked considering the salinity to establish a classification as Digby, M.J., Saenger, P., Whelan, M.B., McConchie, D., Eyre, B., Holmes, N., and Bucher, D. (National River Health Program-Project E1) in their work A Physical Classification of Australian Estuaries identified that Stratification is much more strongly developed in Tasmanian estuaries (Table 2) due to relatively high runoff and low tidal action (Thomson & Godfrey, 1985; Edgar and Cresswell, 1991; Davies and Kalish, 1994). High freshwater flows during winter do not usually flush the estuaries but depress the halocline to greater depths in the water column.

Others work about estuaries had been working by Department of land conservation and development Ocean Coastal Management Program, for classifying the estuaries according to different rules.

In 2002 LOICZ REPORTS & STUDIES NO. 21 Published an paper about "Activities and environmental impacts on the coastal zone of the Pacific coast of South America" (Rodney Martínez Güingla, Giovanni Danneri and Hugo Salgado) this study describe in general southern and northern coastal estuaries.

Investigation and Understanding of physical and chemical processes (or properties) are important to the communities because all the processes that take place in the estuary have to do with the ecosystems around them.

Nutrient Overloading.- nitrogen and phosphorus are necessary for growth of plants and animals and support a healthy aquatic ecosystem. In excess, however, nutrients can contribute to fish disease, red or brown tide, algae blooms, and low dissolved oxygen. The condition where dissolved oxygen is less than 2 parts per million is referred to as *hypoxia*. Many species die below that level, the level of healthy waters is 5 or 6 parts per million. Animals that depend on seagrasses for food or shelter leave the area or die. In addition, the excessive algae growth may result in brown and red tides which have been linked to fish kills, manatee deaths and negative impacts to scallops. Increased algae may also cause foul smells and decreased aesthetic value.

Pathogens.- Pathogens are disease-causing organisms such as viruses, bacteria, and parasites. They are found in marine waters and can pose a health threat to swimmers, surfers, divers, and seafood consumers. Fish and filter feeding organisms such as shellfish concentrate pathogens in their tissues and may cause illness in persons consuming them.

Toxic Chemicals.-Toxic substances such as metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), heavy metals, and pesticides are a concern in the estuarine environment. These substances enter waterways through stormdrains; industrial discharges and runoff from lawns, streets and farmlands; sewage treatment plants; and from atmospheric deposition. Many toxic contaminants are also found in sediments and are resuspended into the environment by dredging and boating activities.

Habitat Loss and Degradation.- health and biodiversity of marine and estuarine systems depends on the maintenance of high-quality habitat. The same areas that often attract human development also provide essential food, cover, migratory corridors, breeding/nursery areas for a broad array of coastal and marine organisms. In addition, these habitats also perform other important functions such as water quality and flood protection, and water storage. Ecosystems can be degraded through loss of habitat- such as the conversion of a seagrass bed to a dredged material island- or through a change or degradation in structure, function, or composition.

Introduced Species.-Intentional or accidental introduction of invasive species may often result in unexpected ecological, economic, and social impacts to the estuarine environment. Through predation and competition, introduced species have contributed to the eradication of some native populations and drastically

reduced others, fundamentally altering the food web. Overpopulation of some introduced herbivorous species has resulted in overgrazing of wetland vegetation and the resultant degradation and loss of marsh. Other impacts include: 1) alteration of water tables; 2) modification of nutrient cycles or soil fertility; 3) increased erosion; 4) interference with navigation, agricultural irrigation, sport and commercial fishing, recreational boating, and beach use; and 5) possible introduction of pathogens. Sources of introduced species include ship ballast, mariculture and aquarium trade.

Alteration of Natural Flow Regimes.-Alteration of the natural flow regimes of tributaries can have significant effects upon the water quality and distribution of living resources in the receiving estuaries. Freshwater is an increasingly limited resource in many areas of the country. Human management of this resource has altered the timing and volume of inflow to some estuaries. Changes in the natural freshwater inflow to estuaries can have significant impacts on the health and distribution of plants and wildlife. Too much or too little freshwater can adversely affect fish spawning, shellfish survival, bird nesting, seed propagation, and other seasonal activities of fish and wildlife. In addition to changing salinity levels, inflow provides nutrients and sediments that are important for overall productivity of the estuary.

Declines in Fish and Wildlife Populations.-The distribution and abundance of estuarine fish and wildlife depend on factors such as light, turbidity, nutrient availability, temperature, salinity, and habitat, and food availability.

Statement of Work/Terms of Reference

The proposed working group would

- (1) Identify the main estuaries in southeastern Pacific coast which are going to be analyzed, based on their extension and their biodiversity.
- (2) Analyze the physical and biochemical processes that take place in the estuaries and establish a classification on those bases.
- (3) Based on this classification, suggest integrated management programs that might be appropriate for each kind of estuary.
- (4) Establish and maintain a Web site as a "virtual workshop" that can be used by the estuarine research community to exchange and discuss ideas, results, and future planning.
- (5) Generate a final report that documents the results and the methods used by the working group.

Meetings: The first formal meeting of this Working Group should take place during June 2004 in Guayaquil, Ecuador in association Colombia, Peru and Chile. Preliminary communications leading up to this meeting will take place during the preceding year and creation of an agenda. The purpose of this meeting is to know

the scientists that will work in the project and to establish the procedures and the agenda that is going to be conducted on the project. A second meeting will be convened in association with the workshop (proposed below) approximately one year following the initial meeting. In this meeting each researcher will show the results that they have accomplished in this period of time and to let the group know how they are conducting the research. A third and final meeting is proposed to take place approximately three years after the initial meeting in order to allow final discussion and to write the final report of the project.

Workshop in 2005: An international workshop on Physical and Biochemical Classification of the southeast Pacific coast estuaries for application of management and coastal arranging program will be convened in order to facilitate inputs to the Working Group and fulfill the above terms of reference. This workshop is proposed to take place approximately one year following the 2004 meeting.

This workshop will provide opportunities to include a greater number of experts than can take part as working group members.

Symposium in 2006: It is proposed that the Working Group, as its final action, oversee convening a symposium on the topic of Physical and Biochemical Classification of the southeast Pacific coast estuaries for application of management and coastal arranging program.

A duration of four years is proposed for this activity. The project would be completed by October 30 2006.

Besides the financial support of SCOR other international organizations like the Intergovernmental Oceanographic Commission (IOC) and the Land-Ocean Interactions of the Coastal Zone Project (LOICZ) can support this project.

Working Group Members– A working group formed of scientists from the region is the best mechanism to focus international scientific efforts on the topic of physical and biochemical classification of the coastal estuaries of the southeast Pacific for application of a management and coastal arranging program. Scientific expertise must be assembled from several different nations and an international working group could help on build the capacity on this topic in developing nations of this region.

- 2 scientists from Colombia
- 2 scientists from Ecuador
- 2 scientists from Perú
- 2 scientists from Chile
- 2 scientists from outside the region

References

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INVESTIGACION. <http://costera.melaque.udg.mx/investigacion.html>

Directrices para las Categorías de Manejo de Areas Protegidas. http://www.unep-wcmc.org/protected_areas/categories/esp/iv.htm

Capítulo 1: Plan Integral de Manejo y Conservación para los estuarios de San Juan. www.estuariosanjuan.org