The freshwater-maritime interface: legal and institutional aspects

FAO LEGISLATIVE STUDY

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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by
Robert D. Hayton
for
the Development Law Service
Legal Office

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FOREWORD

Only a few years ago even the scientific community had not focused specially on the areas where fresh water, descending from the land, meets the saltwater of the seas, as these surge and ebb along all the coastlines of the world. Today scientists are highly active in the study of these zones of interaction, as are local planners and environmental protectionists in many countries. The attention being paid to this "interface zone" by the specialists is not matched, however, by the legal community. With exceptions, even those dedicated to the laws and institutions for water resources, maritime and non-maritime, have scarcely noticed the dramatic intensification of conflict involving some of the most important uses, and protection problems, of water on this planet. A critical and dynamic link in the often extolled hydrologic cycle has, it appears, been too long neglected. It is the purpose of this study to point up the scope of the problems, the work that has begun on the legal and institutional aspects of those problems, and the work that remains to be done.

There is no pretense here to definitive analysis or to exhaustive bibliography. Care has been taken to rely on the most recent information available, but in a study of this kind it is inevitable that occasionally reliance will have been made on an out-of-date law. In this connection, the Development Law Service will welcome being kept informed of recent developments concerning legislation for the management of estuarine zones.

This study was carried out for the Development Law Service by Professor Robert D. Hayton, a jurist with wide experience in, and knowledge of, the development, use and conservation of water resources. Ms. B. Stack, formerly on the staff of the Development Law Service, has contributed original research on domestic legislation on the management of estuarine waters. Mr. S. Burchi of the Development Law Service has been responsible for overall project coordination and editing.

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Chief, Development Law Service

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CHAPTER I - **INTRODUCTORY CONSIDERATIONS**

A. **The importance of the problems**

Water cycles from sea to atmosphere to the land, and back to the sea again. The need for legal regulation and effective management of all fresh water resources is recognized, including at the international level. Water Resources Law, an ancient branch of the law, has made impressive strides in recent decades, above all with respect to conservation, or protection and control, of fresh water resources. Much of the progress has been realized by making known to administrators, legislators, judges and entrepreneurs the interdependencies and interactions pertaining to this ubiquitous, vital element as it moves through the hydrologic cycle.

The Law of the Sea has been the subject, in recent decades, of even more intensive and universal codification and progressive development efforts. The complex interactions of maritime waters with the atmosphere and with the land are now widely recognized, at the level of principle. "Protection of the marine environment" has come to the fore as a major goal for nations and the international community; the importance of pollution from "land based sources" is acknowledged in numerous documents.

But lawyers focusing upon different aspects of the hydrosphere (fresh waters or salt waters) have, with notable exceptions, not acted upon the implications of the full operation of the hydrologic cycle. Some portions of the cycle have seldom been joined systematically to the rest of the "circle". In that connection, additional attention to atmospheric water is undoubtedly merited. But, even with such attention, the circle would still not be completed. It is the purpose of the present study to examine the legal, managerial and institutional aspects of a remaining, physically narrow gap; the zone where fresh waters and marine waters meet and interact, "the fresh water-maritime interface".

"Interface", in this context, should not be seen as a plane of sharp delineation. On the contrary, it is a dynamic, often extensive zone of sometimes violent interaction where the sea and fresh waters overlap, mix and result in specialized ecosystems of enormous importance to man and nature. Fresh water flows into the sea, often effecting far-reaching changes along coasts. Sea water, moreover, cycles into fresh water's "domain" along this interface, often penetrating deeply, and with equally significant consequences.

The dynamics are physical, chemical, biological; the "balances'*, frequently fragile. The import of some of the myriad interaction will here be demonstrated, although briefly. Existing and impending impacts on this interface will be illustrated, and considerations will be inferred from this record. Possible delimitations of interface zones will be set forth. Finally some suggestions for more rational development, use, protection and control will be offered for further consideration **1/**.

The legal aspects of the fresh water-maritime interface are little studied and involve extraordinary ramifications for community development planning and natural resources management in most coastal countries. While this study can be considered a preliminary effort to lay the matters before the reader, it is hoped that further consideration and more specialized work will be stimulated. Much additional food for thought will be found in the rapidly growing scientific and technical literature.

But before turning to the legal and institutional implications of man's dependence upon the waters in question, a familiarization with the physical, chemical and biological equations at work is deemed necessary as a point of departure.

B. Estuarine waters

For the reader not fully familiar with what is taking place where the sea and non-maritime waters meet, nor with the reach of the problems related to the area, some factual observations, some definitions and some examples may be helpful.

Water runs down from the land masses and joins the sea principally via the topographical features we call estuaries and deltas. Thus, estuaries and deltas will receive principal attention. There are, nonetheless, other interfaces between fresh water and saltwater, often, but not always, in some relationship with a delta or estuary. These include wetlands, adjacent beaches and groundwater. The prevalence of the relationships has given rise to the term "estuarine zone" to embrace all coastal situations where there is significant fresh-salt hydraulic interaction.

1. Fresh water contributions

Fresh water "migrates" toward the sea from several sources. The most obvious and usually the most important conveyor bringing fresh water into contact with marine waters is the river or stream flowing into the sea. The force and volume as well the quality of the waterways fluctuate widely, even to extremes, periodically. The waters of some rivers make a more or less direct and uncomplicated entry to the sea, but many others empty into a complex "frontier" with numerous, consequences for adjacent environment. This more difficult passage normally involves a delta or an estuary, or both, as well as, at times, coastal marshes, lagoons or one or more barrier islands or reefs, through and around which the fresh water must move before it becomes so mixed into the ocean waters as to lose its distinct characteristics, especially of salinity and temperature. Because of the frequency of occurrence, emphasis here is on the delta and estuary. Thus, the expression "estuarine zone" will here be used, usually interchangeably with "interface zone".

However, fresh water also enters the marine environment via the bed of the sea, usually quite close to shore, including in an estuary or along a delta. These undersea springs are appearances of groundwater where the aquifers are open to seaward and the normal gravity flow discharges groundwater along submarine "horizons". In some cases these contributions of fresh water to the marine environment are substantial and, until recently, often overlooked. The better known occurrence of the intrusion of seawater into coastal aquifers below sea level is nothing but the converse action, another dimension of the interface.

The contribution of atmospheric water is also important. Rainfall onto the surfaces along the interface may be considerable, even overwhelmingly important as in monsoonal regions. In times of heaviest precipitation, rainwater may also run off the land into coastal waters more or less directly, that is, without first draining into a recognized river or stream. These contributions from the atmosphere form part of any comprehensive evaluations of the complex of interactions taking place in the estuarine zone.

Finally, since discharges within the estuarine zone from sewer pipes and other drains from the land are normally not marine, these too must be placed on the ledger of fresh water contributions, though they be "used" or polluted waters. Similarly, the direct deposition, form barges or otherwise, of sewage and other wastes into this zone can, under certain conditions, add significant amounts of contaminated "fresh" water **2/**.

2. The estuarine equation generally

The marine waters found within the zone may have arrived rather directly from the open ocean's upper layer, driven by the winds and the tides. On the other hand, all or some of the sea waters may have flowed in from along the coast or welled up from benthic regions. Salinity, temperature and kinetic energy vary widely, including from time to time. The marine life and nutrients carried in from the sea will also fluctuate.

The result for the interface zones is oftimes a radically changing environment beyond the tolerance of many forms of life but providing niches of advantage - restricted competition - and favorable conditions for other species. The equation has, it is true, several variables, but the natural shifts from landward as well as from seaward are themselves cyclical and almost always within established limits. Subject to infrequent climatic excesses, the pattern is in the usual case quite predictable, though always gradually being modified. Thus relatively stable, but special systems have evolved, in which each constituent of the estuarine zone, inorganic as well as organic plays its assigned role. Of course, the tides are the "engine" of the exchanges.

It is clear at a certain level of generality, that the interface exists along any seacoast where waters from the land and from the heavens, including waste waters, meet and interact with oceanic, that is, "salt" waters. Although this interface is highly variable, even geomorphologically speaking, several physical features are separately identifiable and are often separately studied.

The estuary is the classical water body where the important physical, biological and chemical processes are most in evidence. But coastal marshes and swamps are often adjacent and closely interrelated with the estuaries. Where the force of river discharges is strong enough, freshwater sustains its identity far offshore, beyond the mouth or mouths of the physical estuary. Thus, the interface zone is in fact extended into offshore waters.

Many rivers, as they flow into the sea, have formed substantial deltas which profoundly affect the natural processes taking place at the interface. Some deltas front on the open sea itself, or on a gulf or bay. In a few cases the river has formed a delta "upstream", which then faces an estuary, which in turn is directly connected to the sea. The combinations are many and changeable.

Inshore coastal waters may have significant interface characteristics, although deltaic or estuarine processes may not take place there in the usual scope or manner. The correspondence is particularly marked where the continental shelf is shallow or there are along-shore currents displacing water and beach substances (including biota) laterally, and an estuary or delta is nearby. Water, organisms and inorganic matter from the beaches and shallow marine areas are often transported **into** the estuary or the delta, as well as vice versa, adding to and subtracting from the elements and associations where freshwater inputs are mixing with salt water.

The interactions deemed to be "estuarine" are not limited to tiny, narrow-mouthed inlets connected to river mouths. Deeply indented "bays" and "gulfs" usually are, if not true estuaries, estuarine; even not-so-deeply indented bays and gulfs, even bights, may be in fact - depending on the strength of freshwater discharges, winds and currents - estuaries.

Thus, in delimiting an estuarine zone it is often not practical for many purposes to draw a hard and fast line simply across the outer reaches of a delta's land formations, or straight across the mouth of an estuary. The interface persists alongside and in front of these readily identified topographical features, as well as "inside" and upstream (and underground) to the head of the marine influences.

The consequence of these interface problems is the perception of a clearly discernible area with oscillating, often indistinct, boundaries, including regions subject to the so called "estuarine influence". Within this total zone, the multiple processes resulting from the combination of the intermixing of the waters, their contents and the lands and beds involved, compose this pivotal "estuarine-coastal environment".

3. Estuarine processes

Estuarine zones "host" rather unique processes that contribute to the equilibrium of the biosphere.

a. The physics of mixing

The varied forms of estuaries range from the coastal plain type to the steep-sided fjord. One feature, nevertheless, they share: they are regions where rivers and the sea meet and interact. This interaction is compounded by the tides, whose range may be increased within the estuary **3/**.

In order to understand the circulation of water in an estuary it is essential to consider data on the contributions of fresh water, including from rainfall and groundwater. River discharges affect directly or indirectly most or all of the estuarine parameters. In the catchment area of the Gulf of Guayaquil estuary (Ecuador), for example, the largest on the South American coast, 95% of the annual precipitation occurs during January to May. The winds in the estuary vary, too, according to the dry or wet season. Most important, "The Gulf of Guayaquil receives runoff from some 20 rivers that empty a drainage basin with an area of about 51,230 Sq.Km. These flows fluctuate by season and source, causing varying patterns of circulation

within the Gulf" **4/**. River inflows are sometimes through extensive swamps where vegetation performs important filtering and stabilization functions. Canalization of the river in such cases, and the dedication of the reclaimed swamps to agriculture (especially if crops are fertilized and chemically sprayed) can produce substantial damage in the estuary **5/**.

Circulation is usually differentiated between an inner and an outer estuary; river outflow and tidal currents affect each other in the "inner" part. Time-dependent motion in estuaries is further complicated by the tides. "Tidal currents... exert a profound influence through the turbulent mixing they produce. This tends to break down the interface between the river water and salt water and produce a mixing of the two waters through a part or a whole of a vertical column. ...A part of the tidal energy is converted into kinetic energy of turbulence..."**6/**.

The entry of river water into the estuarine zone is more than a question of quantities and timing of flow. "Another common factor associated with freshwater drainage and estuarine circulation is the delivery of a load of river-borne silt. This can have the immediate effect of reducing transparency and tending to offset the effects of nutrient enrichment upon the level of primary productivity" **7/**. From the viewpoint of navigation, shipping channels are often clogged thereby. The nutrients are fed upon by the phytoplankton. Zooplankton and small filter fish, for example the thread of herring, consume phytoplankton and are in turn the forage for larger carnivores, e.g., tuna.

A basic variable at the interface is salinity. Some estuaries are dominated, at least for sustained periods, by the riverine discharge. Others are dominated by the water and action of the sea, where the river flow is relatively weak or the tides are strong. Many estuaries are of the "well-mixed" variety, such as the Weser in the Federal Republic of Germany **8/**. Depending on this mixing process, and the basic salinity of the various water impacts, the salt levels and salt fluxes will vary. Knowledge of the salinity gradients is indispensable to an understanding of the estuarine biological processes.

Estuaries are complicated. "They are continually in motion with cycles of variation that may never be repetitive and there is close inter-linking between the physical, chemical geological and biological systems... " **9/**. River water, being less dense, tends to flow outward over the saline layer. The "interface" tends, thus (and absent tidal action) to be horizontal, extending up the rivers that feed the estuary (as far as mean sea level) and out to sea. But, except for estuaries on the shores of semi-enclosed seas and behind barrier islands and peninsulas (a considerable number), the tides cause the entire contents of the estuary to oscillate. Truly freshwater is found only quite near the head of the estuary **10/**.

It is generally agreed that "estuaries are better at diluting and removing pollution than the tributary river" **11/**. But a conservative, non-decaying pollutant, discharged to the estuary at a constant rate, will be distributed both upstream and down by tidal action **12/**. Each ebb tide has to remove a volume of fresh water equivalent to the freshwater inputs during the time that has elapsed since the last ebb tide. What is actually evacuated is not "river water", however, but some turbulent mixture drawn out from the waters in complex circulation **13/**.

b. Spawning and nursery grounds

Many marine organisms have their spawning and nursery grounds in estuaries. With man's interventions in these naturally productive areas, "significant perturbation, of the estuarine environment has resulted" **14/**. Major demands on the estuaries' dissolved oxygen are made by the organic material delivered from rivers and from direct waste disposal. Anoxic conditions, that is, devoid of all "normal" aerobic life, result when the oxygen demand rises too high. The operation of food chain is intimately linked with the physical rhythms of the estuarine zone **15/**.

It is worth noting that the adults of estuarine decapods (a benthic species) depend upon the offshore sea during their larval stages. "Many principal off shore fisheries are dependent on stocks whose young must have access to the protection and nourishment afforded by estuarine tidal flats and the mangrove swamps... Most of the world's marine fish catch still comes from coastal waters, usually under variously strong estuarine influence" **16/**.

c. Nutrient inputs from fresh water

The natural supply of nutrients to estuaries from freshwater sources usually makes them areas of high "primary" production in the food web. But the phytoplankton growth may be inhibited by one or more factors. High turbidity within the estuary, and too-rapid flushing time by the tides are such factors **17/**.

River mouth-estuarine zones are among the most highly productive ecosystems on earth. A nutrient-rich substrate is continuously in the photic zone; the ample flow of all ochthomous nutrients is quickly recycled there. The interactions are delicately balanced among the biotic and abiotic factors responding to shifting salinity and temperature gradients **18/**.

In the lowlands around a river mouth, the deposition of silt by the annual floods encourages plankton blooms which attract schools of fish, "providing vastly increased fishing opportunities" **19/**. Control of the water in the Mekong delta "is the single, most important change that can bring about dramatic increase in the delta's agricultural production" **20/**. It has been concluded that diminishing silt deposition in the Mekong delta, by the construction of dams upstream, is "no longer to be considered a negative agricultural factor" **21/**. There is apprehension, none the less, that such deprivation may result in a decline in fish catches in inshore areas, based on the experience in the Eastern Mediterranean following the construction of the Aswan high dam on the Nile **22/**.

On the other hand, net fish production gains are common from the reservoir fisheries created as a result of dam construction, such as on the Nam Pong reservoir (Thailand) and the Nam Ngum tributary reservoir (Laos); and Lake Nasser, Lake Volta, Lake Kainji and Lake Kariba in Africa **23/**. Management decisions are clearly involved in calculating and selecting the fisheries trade-offs, often "relegated to an ancillary role or even ignored in planning water resources development projects" **24/**.

d. Atmospheric interaction

Most estuaries are relatively shallow, making them highly responsive to the processes of interaction at the water-air interface. Estuarine circulation patterns and water level, temperature and salinity can be dramatically affected by the passage of weather fronts **25/**.

In some locales, the nitrogen, contributed to an estuarine system by direct precipitation, equals and in some seasons exceeds, the nitrogen brought into the estuary by watershed runoff. The cyclic exchange of sea salt between the rivers and the sea includes the salt's transport from the oceans's wind-stirred surface into the atmosphere where the particles of salt act as condensation nuclei for raindrops. "This process accounts for more than 90 percent of the chloride and about 50 percent of the sodium carried to the sea by rivers". The bacteria within marine sediments, though highly limited, play a major role in replenishing the oxygen and produce carbon dioxide that is utilized by phytoplankton, which in turn release oxygen; the sulfate bacteria recycle sulfur and oxygen **26/**. And the microsurface layer of an estuary may also be a source of pollution that is transported elsewhere atmospherically **27/**.

From the air passing over the estuary or delta and the associated areas come the rain and snow that fall directly into the estuarine zone. These precipitations constitute direct contributions of fresh water at and near the interface. In many regions this may be slight as compared to the riverine contributions; in some areas even the water content from sewage and sludge discharged locally into the estuary exceeds rainfall. But it is also true that in areas of very heavy seasonal precipitation along the coast, water received from the atmosphere constitutes an important portion of the total fresh water budget of the estuary **28/**. The quantity and timing of the contributions of water from the atmosphere are known to influence estuarine biological processes by changing the mixing ratios of marine and fresh water and the salinity of the top water layer.

Moreover, where appreciable atmospheric pollution is deposited in the estuarine zone, water quality problems are likely to arise, or be

exacerbated. To be sure, the contaminants transported into the interface zone by streams and ground water or by seawater, are usually of more concern. The total picture of the estuarine environment, none the less, includes wind-borne and precipitation-borne contamination. And what may not be "pollution" in terms of harm to man, or in terms of having been introduced by man, may be pollution to the marine biochemist who monitors the impacts on marine organisms indirectly important to man as part of the food chain and the larger environment in which the organisms live out their life cycles.

Precipitation and fallout of atmospheric pollution is today of increasing concern. That rain carries significant amounts of heavy metals has been proven with respect to, for example, the Firth of Clyde in Scotland, including lead, zinc and copper **29/**. The atmosphere has been shown to be at least as important as the Rhine River with respect to heavy metal and metalloid pollution of the North Sea. Significant mercury, cadmium, lead, zinc, chromium and copper from atmospheric sources have been measured for the German Bight **30/**.

e. Interaction with the underground environment

Groundwater as a component of estuarine waters, and the better known penetration into aquifers of seawater have already been mentioned. Yet the interactions between the underground environment and the surface environment, made possible largely by the movement of water, merit further explication. Contamination of aquifers by inflows from the estuary, and of the estuarine zone by outflows from aquifers are both serious concerns.

The submarine discharge of fresh groundwater is widespread if little studied **31/**. It occurs anywhere an aquifer is connected hydraulically to the sea through permeable bottom sediments and the "head" is above sea level. Freshwater enters marine waters "through a narrow gap between the surface water-seawater interface... and the water table outcrop at the beach". Because of the entrainment of some saltwater from the "zone of diffusion", the seaward edge of groundwater discharges will be brackish **32/**. "An underlying saltwater wedge typically intercedes" the aquifer below the outflowing freshwater along the coastline, as it typically does beneath fresh

surface water in an estuary. This wedge impedes the downward mixing of the lighter groundwater, magnifying the pressure on the fresh goundwater from unconfined aquifers to discharge close to shore - including an estuary. The zone of discharge may be above the surface water line at lowtide, but such water is still classified as groundwater. Confined aquifers (artesian) "may outcrop from the ocean floor at any depth or distance from shore. Artesian springs are common off many coasts". Globally, the volume of groundwater discharge into the sea has been estimated as high as 10 percent of the surface runoff. In some cases, submarine discharges of ground water can be of "major ecological significance", including the provision of otherwise unaccounted for nutrients to the estuarine zone **33/**. Much marine ecological data could be in error as a consequence of overlooking the effects of submarine groundwater discharge **34/**. The most vigorous mangrove stands grow in riverine-estuarine conditions, where their roots can absorb nutrients from the below surface sediments where the groundwater table is close to the surface **35/**.

4. Definitions and delimitations

There is no completely typical estuary or delta. Moreover, a true estuary may be denominated, as shown above, "bay" or "gulf". There are indeed numerous important estuaries. One classification system differentiates among three types on the basis of physical form: delta, funnel, and barrel. Some are small, others gigantic in extent. Even the larger formations range from the mouth of the Gambia River in West Africa to the mouth of the Amazon River in South America. Estuaries are also classified climatologically (polar and subpolar; westerly temperate; tropical and equatorial). In high latitudes glacially formed estuaries are typically fed by rivers low in sedimentation and therefore "open". In the temperate latitudes glacially formed estuaries tend to be blocked quickly since glaciated debris is available in great quatities. At low latitudes, under semi-arid conditions, weak river system discharge and ample availability of desert sand or coral reef growth leads to blocking. In estuaries in equatorial latitudes and with substantial river flow, the mangroves extend to stabilize new deposits, but the growth of coral is checked **36/**.

An estuarine zone may have several components: an estuary, a delta, a port area, marshlands, mudflats, and adjacent beaches with their belt of shallow waters. Each component is related to another in a semi-independent ecosystem: the estuarine zone. On the other hand, some strong rivers have filled in their estuaries and pushed their deltas out to sea. There are many "stages" in this constantly changing interface. A brief description of each major component may prove useful.

a. Estuaries proper

Simply stated, an estuary is a dynamically evolving landform where a river meets an inlet of the sea. In geomorphological terms, it is a river valley that is open to the ocean **37/**. In many cases the estuary covers a "drowned" river valley into which the sea now penetrates; the lower end of the river channel and valley, once above sea level, are now below sea level, usually because of the substantial rise in the level of the oceans worldwide as a result of ice melt after the last glacial age.

The estuary proper is generally deemed a semi-enclosed arm of the sea, headed by a river, that is influenced by the tides and by the mixing of fresh water with sea water. Where the fluvial discharge is high, the mixing may extend beyond the physical inlet, even to the edge of the continental shelf. The following definition differentiates sub-components: "An estuary is an inlet of the sea reaching into a river valley as far as the upper limit of tidal rise, usually being divisible into three sectors: (a) a marine or lower estuary, in free connection with the open sea, (b) a middle estuary, subject to strong salt and freshwater mixing; and (c) an upper or fluvial estuary, characterized by fresh water but subject to daily tidal action" **38/**.

Estuaries are ephemeral features from the geological point of view, as are lakes. In time they will, in the normal case, be filled up with sediment and cease to be estuaries. Most of today's estuaries are no more than 10,000 years old. The rate of their march toward extinction varies greatly, depending on several factors. But an estuary not interfered with by man - or by nature, for example, by earthquakes, volcanic eruptions or overwhelming washout - may be regarded as likely to remain, within the time frame of normal planning, in a state of near-equilibrium. The situation is dynamic and

turbulent, however, and relatively drastic changes, especially biological and chemical, occur frequently and cyclically within the "equilibrium". An estuary "constitutes the most complex of all coastal environments" **39/**.

Beginning with their creation, sedimentation and slightly oscillating sea levels have been reducing most estuaries. Sediment is brought into the "vessel" with the basin's stream flow or from along the shore by drift. Rivers with the smallest loads of sediment normally still have more open and perhaps deeper estuaries. If the sediment transport is primarily along the shore, a coastal lagoon or sound, parallel to the coast, is the natural result, following the growth of barrier islands in front of the estuary or river mouth. The waters behind such barrier islands in a lagoon or sound are usually "estuarine", that is, a combination of seawater and freshwater, with the mixing process still occurring and with biota typical of estuaries for that climate and region. The "head" of an estuary is in many cases many miles landward, upstream, to the limit where the pressure of the tide is felt **40/**; the intrusion of salt water is not so far inland.

The "mouth" of an estuary may be open, or encumbered by a submerged or partially submerged bar, or by one or more islands. In close connection with the main estuary may be tidal flats, salt marshes, lagoons and even semi-separate or sub-estuaries. The hydraulics alone can be very intricate **41/**.

Both significant tides and significant freshwater inputs are required in order that a coastal water body be designated, technically, a "true" estuary. In seas such as the Mediterranean, where there is little tidal action, few substantial estuaries are found, though numerous rivers discharge into such seas. Rivers are frequently intermittent in semi-arid zones, so that their estuaries may be deprived of fresh water over long periods.

b. Deltas

Rivers with a heavy silt load and substantial flow tend in due course to build extensions to the land by depositing sediment or alluvium alongside and at the front of the river mouth. The resulting land form is known as a delta.

Deltas typically are traversed by several distributaries from the main stream as freshwater flows seek the line of least resistance down to the sea.

Deltas form most easily in seas where wave action is limited and the range of the tides is low, minimizing the oceanic removal forces in front of the river mouth. The Mississippi, the Orinoco, the Nile, the Po, the Rhone and the Danube are prime examples - all rivers with substantial discharge rates **42/**. In the case of the Nile, the major contributor of fresh water to the Mediterranean, the river in ages of very low sea level had cut a valley and canyon in the continent below present sea level and reaching nearly 1,000 km upstream to the vicinity of Aswan. Subsequently the entire "drowned" valley was filled and the well-known Delta was built by alluvial sedimentation. An earlier true estuary no longer exists. The Mississippi and other rivers with great deltas similarly have passed through the estuary phase. It has been said that "the delta is the enemy of the estuary" **43/**. More accurately, the upstream sediment course and estuarine environment may simply favour relatively rapid prograding of the valley by sedimentation. Afterward the river continues to push the fill into the sea, extending its delta **44/**.

Though not estuaries strictu sensu, deltas are in the larger sense "estuarine" in that tidal action, though limited, affects and mixes with the river water in the delta, and the discharges are carried onto and absorbed into the sea in front of and alongside the delta. The delta and its environs are a zone of fresh-maritime water interface of lesser and different dynamics than the usual estuary, but significant and vulnerable nevertheless.

c. Marshlands and mudflats

Adjacent to or even virtually surrounding an estuary or delta, large land areas may be marshy or permanently muddy, washed by the tides and receiving little in the way of fresh water except from rain, snow and creeks. These saltmarshes and tidal flats are intimately linked with their estuaries or deltas, especially biologically **45/**. They provide the natural habitat for many species of birds, animals and plants, which in turn participate in the food webs linked to the estuary. Some species migrate back and forth between

the coastal waters, the marsh and the estuary, for example **46/**. No management scheme for an estuary can afford to ignore the importance of these adjacent lands. Filling them in or draining them for purposes of housing or industrial plant, or excavating them for marinas or harbours can be gravely counterproductive **47/**. The marshes and tidal flats are part of the estuarine zone and, therefore, must be embraced in planning for the permissible modification of the fresh water-maritime interface **48/**.

d. Beaches and adjacent shallow waters

There are at least two reasons why the conditions of the beach and shallow areas near estuaries must be taken into account in connection with estuary and delta management. In many cases there are significant biological interactions between the near-shore shallow waters, the beaches and life processes in the estuary. Species migrate, sometimes to and from marshes or mud flats behind the beach. Or the combination of tidal and alongshore current actions will carry species and materials into the estuary from these adjacent coasts, and vice versa. Such interaction is often limited, but major storms and floods can and do cause large displacements. The chief basis for tying stretches of beach and coastal waters to any particular estuarine management scheme is man's intervention along the coast, such as the extraction of sands and gravels **49/**. Such removal affects natural sediment transport along the coast and can cause disruption, if not extinction, of the biotic habitat forming part of the estuarine system. Man's attempts to control the sea by, for example, the construction of breakwaters and groins along the coast further affect the nearshore physics, bringing about alterations at the mouth or mouths of a nearby estuary, if not actually inside it. Nearby coastal stretches may, thus, need to be embraced in particular estuarine zones.

Consequently, in ascertaining the reach of an estuarine zone of influence, any beach and shallow water areas, and of course nearby islands, must be evaluated for their natural interactions with the delta or estuary, and for any existing or anticipated human activities affecting such areas. Where population densities are increasing or industrial plant is expanding, additional pressures on these coastal areas are to be expected **50/**.

C. Man's use of estuarine resources

Man's intervention and use of estuarine resources, and natural processes, are the cause of constant change of conditions in the interface zones. It is important to note that, while some such changes may be brought about by natural or man-induced processes at the estuary, other changes are the resultant of events or processes which take place elsewhere in the drainage basin. Perhaps the most prominent example of estuarine impact of events far removed from the estuarine zone is the loss of fisheries off the Nile delta due to the construction of the Aswan dam and the loss of downstream freshwater inflow from the Nile.

The rational management of any one estuarine resource necessitates appropriate evaluations of actions in relation to all affected processes. The preparers of environmental impact assessments need to attain a holistic view of the zone involved. The natural situation having been set forth at the outset, it is now appropriate to survey briefly the uses of the zone by man.

1. Fisheries, animals, and plant life

From earliest times man found fish and shellfish in great numbers in the estuarine waters. Prolificacy, along with prodigious plant life, also attracted, fed and sheltered countless numbers of animals, especially birds and mammals. Fishing and hunting, then became the most important estuarine activities.

Estuaries, "in the vicinity of extensive marsh-estuarine systems, are among the world's most productive waters in terms of both commercial and sports fisheries" **51/**. The fish and shellfish catches in the estuarine waters can be classified in three categories: 1) wild resident species, 2) wild transient species, and 3) cultured species. The resident species spend virtually their entire life cycle within estuarine waters. These include, for example, oysters, certain clams and finfish, such as the striped bass. The transient species include those that move through or into the estuary for feeding or breeding purposes, but spend the major portions of their life cycles out to sea or in the streams and lakes of the basin. Examples are

salmon, sturgeon, shad and herring. Regardless of the quality of their estuarine environment, and any management measures taken wihin the estuary, transient species may be subject to intensive predation both offshore and upstream. They come under the jurisdiction of inshore managers for a part only of their lives **52/**.

Cultured and semi-cultured species include those seeded or hatched and raised and harvested entirely within the estuary and those released to mature in the ocean after reaching a certain stage of development. Such aquaculture enterprises are expanding rapidly in many estuarine zones. Estuaries are also natural nurseries of vital economic importance **53/**.

Only nominal mention can be made here of the many aquatic and shore birds and mammals that inhabit the marshes, deltas, beaches and waters of estuarine zones around the world. Attracted by the marine food supply and sheltered by the often profuse vegetation, these creatures occupy numerous niches in the estuarine ecosystem. The animals in turn are taken by man for food and for fur, and in some cases still, for sport or for feathers.

2. Harbours and Navigation

Among the ancient uses of the interface is water transportation. Many estuaries offer safe havens for vessels; their location at the mouths of rivers facilitates navigation to and from the interior, where streams are navigable. And where they are not navigable in their natural condition, improvements are frequently undertaken to make them navigable.

This use of the estuarine zone is of such moment commercially and as an organizing nucleus of civilization that major cities are usually found in close association with ports. The importance of these ports and their cities for the estuarine zone of influence is that the port managers must accommodate to the freshwater that arrives from upstream, including contaminated water from ports and settlements upriver, as well as the better known sea-related problems such as storms, wave damage and sand bars.

3. Waste disposal

The presence of large populations within the estuarine zone ordains that vast quantities of rubbish and human body wastes must be disposed of. Some estuaries, and sectors of other estuaries have insufficient removal by tidal action, or insufficient push from freshwater inputs to flush out much waste. Some estuaries have great waste disposal powers. Even in industrialized countries the treatment of such wastes has been rudimentary, or totally lacking, until quite recently. And the sewage and refuse descending to the estuary from upstream in the basin must also be deemed a "use", as unwelcome as these wastes may be to those dwelling at the interface. Although many species of estuarine organisms have adjusted to, or even thrived upon, human garbage, even these species have toleration limits. Other species, such as diadromous fish, may have been driven out. Moreover, from the viewpoint of preventive health, and of olfaction, many estuaries are now foul smelling and their waters hazardous. This use is on the increase almost everywhere; the costs of neutralizing sewage effluents, astronomical.

Finally, man has long used rivers, estuaries and shallow coastal waters as the location for industrial effluent outfalls– still usually untreated– and for storm sewer outlets. Even where such discharges are offshore and not near estuaries, the aftereffects are likely to find their way mechanically or biologically into the estuary. The impact of these waste waters on the estuarine biota can be detrimental, even catastrophic; occasionally they have been found to be beneficial.

4. Other uses

The use of estuarine zones for recreation and tourism hardly requires elaboration, as resorts and individual vacation retreats dot many coastlines.

In addition to the ordinary human uses of estuarine zones, a number of less common activites are practised in some regions. These activities include the capture of energy from tidal action, placer mining in the bed of rivers and estuaries, the extraction of salts, and the cooling of power plants. Some of these uses may see wider application in the future.

D. The changing conditions of interface zones

Many independent studies have been carried out concerning estuary deterioration and in some cases the destruction of the viability of an estuary as "organism" **54**. Here an overview of some major conditions that require management responses is presented to make clear the need for comprehension of the technical factors as a basis for decision.

1. Estuary modification

The most common major modifications result from the city and seaport situated at the estuary. This includes most of the principal ports in the world. That is, estuaries are enhanced for navigation purposes by dredging, including of bars at the estuary mouth and of channels, and by facilities construction. All such modifications, and others, were intended to be "improvements," taking advantage of the natural site and providing valuable services. Be that as it may, undesirable side affects have often accompanied growth within the interface zone, where there has been inadequate planning and management and insufficient data. But also river flow modifications "for agriculture, flood control or hydroelectric generation" have had adverse consequences "due to alteration of the salinity distribution and circulation in the river estuary" **55/**.

Access to harbours requires the maintenance of channels sufficiently deep for navigation. With larger ships and the attendant enlargements of, and improvements to, wharves and docking basins, demands for estuarine changes have accelerated significantly. Traffic, too, has increased. Tidal flushing, coupled with relatively rapid freshwater-seawater mixing has enabled most estuaries to cope with their harbour-originated burdens in the past. But the present and the future are not bright. The discharge of wastes of all kinds into ports has multiplied and increases still **56/**.

Changes are by no means all caused by human intervention. Indonesia, with an extraordinary diversity of coastal features, feels the effect of man, but tectonic, volcanic, hydrographic and organic processes are responsible for rapid change, particularly in deltas and mangrove swamps **57/**. In many

drainage basins, nature delivers heavy loads of silt to the delta and on into estuaries or the sea, because of severe erosion upstream. Poor range management may be partly at fault, but natural conditions are usually paramount. To the extent that deforestation cannot be reversed, or at least stopped, the seasonal impacts of stream inputs become increasingly extreme, with concomitantly abrupt alterations in the estuarine equation. Deforestation reaches to the mangrove forests as well, weakening the capacity of deltas and estuaries to withstand destabilizing blows. The well being of tropical estuaries has been traced to the conservation of tropical forests **58/**.

The siltation of delta channels and estuaries is not merely a concern of the navigators. Longshore currents continuously form and renew sand bars, which inhibit the normal flushing of the estuaries, effectively deepening them. Constriction of the mouth of an estuary, through sand bar formation, can result in an accumulation of pollutants there, whether coming from landward or discharged offshore. The result: decreased productivity of the fishery **59/**. In many cases, dams and barrages have been built, or are planned, in the rivers in efforts to mitigate flooding in the delta region, to bar the intrusion of saltwater, to divert water from certain channels for various purposes, or otherwise to regulate the river system. Some such projects are calculated to modify the estuarine situation. Changed river flows, inducing displacement upstream of higher isohalines in an estuarine ecosystem can be beneficial to certain organisms under some conditions. Stabilized delivery of nutrients, moreover, might benefit the fisheries; regulated flow may alter the penetration and abundance of various organisms to the advantage of some species' spawning. The erection of barrages in or near estuaries may be, on balance, justified, but the "costs" to the estuarine zone should be carefully weighed.

Dredging of estuarine bottom areas, frequently coupled with construction including causeways and inlets, and other disturbances such as swamp filling and sand and gravel extraction, effect long-term as well as short-term changes in the dynamics of an estuary. Circulation is altered; turbidity is increased (and light penetration is reduced), at least for a time. Mangrove coverage is reduced, as is benthic vegetation. Other environmental effects - not all deleterious - involve altered tidal exchange regime including

saltwater-freshwater mixing, changed nutrient outflow from marshes and swamps, increased (or decreased) saltwater intrusion and creation of conditions highly susceptible to recurrent low dissolved oxygen levels **60/**. Moreover, corals, oysters and barnacles are particularly vulnerable to siltation. In some parts of the world, sizeable portions of the estuary marshes have already been lost to housing and industrial development. Further losses are expected to have negative impacts on, for example, anadromous fish runs.

2. Estuarine pollution

Estuaries are, after all, sinks, into which drain and fall the residues of man's activities, along with the suspended and dissolved substances, living and non-living, active and inert, that nature flushes into the estuarine "receptacle" **61/**. Urbanization and industrialization in all parts of the world, often clustered around estuaries and streams that flow into estuaries, are indications of man's progress, as well as his increase. But these settlements and industries have often turned naturally enticing areas into overcrowded and underserved centres of waste production. Associated water bodies have become open sewers in many cases. Sharp reaction to the negative aspects of man's contamination of his environment has spurred attention at all levels to the intricate problems generated by expansion and development **62/**. Rivers, banks, bays and coastlines have attracted people and industry in vast numbers. Job opportunities, transportation facilities, water supplies and traditionally easy waste disposal have combined to spell explosive growth in many of these regions. And the concentration of populations and industries in the estuarine and riverine zones has not abated. Disposal of garbage and domestic effluents remains a steadily increasing problem **63/**. Chemical wastes and other industrial discharges multiply **64/**. Pesticides and fertilizers are applied ever more widely. Overall, rapid growth of these sources of interference, only occasionally clearly beneficial, is continuing. The loads now carried by the rivers down to the sea are diminishing in a few systems only **65/**.

a. Synthetic compounds

A number of synthetic chemicals have been shown to be extraordinarily persistent in the marine and freshwater environments; resistance, meanwhile, has been developed by new forms of herbs, fungi and insects. Nature itself imposes rather extreme stresses on the estuarine environment, but the species that live there, and those that visit or pass through, have developed tolerances to the natural usually rhythmic changes. Man's activities in recent times are responsible for unusual and unnatural alterations, interferences with the naturally expected. Above all, "artificial" chemicals are often devastating. To be specific, to control pests, stable chlorinated compounds such as certain herbicides, insecticides and fungicides are now widely applied, including direct insertion into estuarine waters. Pentachlorophenol, DDT, Aldrin, endrine, mirex and kepone, for example, are highly toxic to aquatic organisms. Whatever their worth as agricultural, public health and industrial "instruments", their toxicity must not be ignored in the specialized and vulnerable estuarine environment.

Since the subsurface currents in estuaries flow generally toward the land, removal of material to the ocean is naturally restricted. Tidal action, wind, water exchange dynamics and particle size determine the length of time organic pollutants will remain suspended before being deposited among the bottom sediments. Organic and inorganic material will in time settle to the bottom, if it is not withdrawn to the sea through the mouth or mouths of the estuary. Where the ocean's access is restricted, as in the cases of estuaries with barrier islands and with light thrust from the streams, little contaminating material escapes. Even deposition to the bottom sediments is neither absolutely final nor innocuous. Tidal currents frequently move the sediments around to areas of accumulation. Such turbulent transport exposes the material once again to the free swimming organisms of the estuary. Deposits are in any event the subject of benthic and microbiological action.

b. Hydrocarbons

Pollution of the sea by oil is now a frequent occurrence **66/**. Several coastal environments have been severely impacted by major spills from oil

tankers. The immediate toxic effects of aromatic hydrocarbons in the estuarine zone is unquestioned. Some undamaged species have continued their normal life cycles after oil spills. A significant number of species have disappeared, permitting some "opportunistic" species, scarcely present before, to proliferate. Many other types and instances of estuarine contamination by hydrocarbons and petrochemicals could be discussed. Whatever the long term consequences of sudden large oil and chemical spills and discharges, the health of estuarine and coastal areas is seen as threatened.

c. Polluting agricultural activities

The applications of fertilizers, insecticides and herbicides in agricultural operations can be harmful, as can other agricultural activities, to deltaic and estuarine fisheries for example **67/**. Agricultural return flows carrying excess fertilizer loads, especially nitrogen and phosphorous compounds, have resulted in serious pollution to downstream water bodies. Resulting algal blooms, some with biotoxic metabolites, and widespread oxygen depletion, can be lethal. The effects on the spawning and nurturing of marine organisms, especially in highly productive estuaries, of the enrichment from the presence and interactions of various chemical elements, has become a major concern.

d. The problem of heavy metals

It has been stated that "conditions for the mobilization of metals may be particularly favourable in estuaries in view of the fluctuating salinity and the disturbance of the sediments by currents or by dredging, and that as a result, contaminated sediments may persist as sources of metals even when the original source" has been shut down. Moreover, metal deposits are enriched in the estuarine waters, chiefly from riverine inflows, making estuarine zones a place of bioaccumulation of metals, and of other inorganic and organic contaminants **68/**. The concern over the increased levels of heavy metals in estuarine waters has spurred special scientific investigation in efforts to assess the biological effects under various circumstances. Mercury appears to be the most toxic to estuarine organisms. Larva and young animals apparently are more vulnerable than adults to heavy metal toxicity;

temperature and salinity may be variables that affect resistance. Acute heavy metals poisoning of human beings, especially of fishermen and their families who subsist chiefly on seafood, has been confirmed.

e. Other pollution problems

Pollution problems cannot be dealt with here either comprehensively or in any detail. Nevertheless, brief mention should be made of a number of other considerations that affect the estuarine zone. Where estuaries are used or are intended for use for recreational and aesthetic purposes, including the attraction of tourists from abroad, sensibilities dare not be seriously offended by stench or the presence of foul or unappealing substances in the waters or on the beaches. An excess of nutrients in the water, delivered via freshwater runoff and pipe and ship discharges, often yields dense algae growth that is, among other things, annoying. Industrial and domestic wastes and suspended sediment can make the whole area unattractive and odorous. The protection of bathing beaches has received much attention all over the world in recent years. Even where beaches are not within the estuary, river-borne and other pollution can reach nearby shores by lateral current and, of course, by carry-back from outfalls to the sea. In short, if tourism and recreation are to be promoted and retained, water quality in the interface areas so used needs to be, where practicable, above the minimum for municipal and industrial uses **69/**.

The penetration of saline water upriver and intrusion into valuable groundwater constitutes another serious type of pollution. The problem with respect to surface waters is notorious and requires no elaboration here. The penetration of seawater underground is fully as injurious, whether the groundwater's use be for irrigation, industrial or other purposes. Because of the generally contaminated condition of surface water in the estuarine zone, and the intensification of human activities in and near many estuaries, well water is more and more resorted to. Drinking water, for example, an increasing proportion of which is from groundwater, must be from non-saline sources. But overpumping of the aquifer in or near the estuarine zone induces landward displacement of the subsurface saltwater-freshwater interface **70/**. The long-term persistence of groundwater pollution is well known. The responsibility for water quality, including groundwater quality, in estuarine

and coastal zones must be fixed, taking into account the marine dimensions of the problem, and also urban, fisheries, shipping, agricultural and land use planning jurisdictions, because the collaboration of the agencies concerned with these and any other aspects is indispensable. Coordination and integration of the relevant functions is the ultimate concern of the present study.

Pollution from leaking storage tanks, dumps and landfills, whether these contain gasoline, or chemicals or other leachable contaminants, has become a major problem in many countries. These percolating liquids are entering aquifers on a grand scale. In innumerable cases, the estuarine area is where this lethal leakage is taking place. Service stations, depots, and other storage sites are principal sources, but of course installations in ports and marinas are also contributors. Detection is slow and remedial action costly **71/**.

Biological productivity in the marine environment is greatest in and around estuaries and along coast lines, precisely the areas receiving the most pollution. Some changes may be beneficial overall, but many are not. Thermal pollution of coastal waters, by discharges of cooling water from generating and industrial plants, is another concern, including with respect to the effect on shellfish and other organisms held in estuarine mud. In tropical areas animals already live near the upper limit of their tolerance to heat. Changes caused by many pollutants may not materialize for tens of years. Thermal pollution can make estuaries unfit for commercially valuable fish and shellfish species and lead to the increase of undersirable species, as well as of predators such as drills and borers.

Pollution can damage fisheries in several ways. The failure to deal with the effects of water pollution is most clearly brought home when fish kills receive public attention. Specific toxins such as pesticides, or oxygen depletion may kill fish directly. Spawning grounds may be covered over by sediment. Changes in water temperature can alter fish behavior and abundance. The ingestion and absorption of pathogenic organisms by fish can lead to danger to human health; some pollutants degrade the flavour of fish so as to make them unacceptable in the market.

Of key importance to water resources management is the fact that the ordinary measures of protection against pollution cannot be applied within the estuarine zone because of the incessant fluctuations, both spatially and over time. Planning and management measures must be applied to the sources of discharges to the estuarine area, such as rivers, sewers and other point sources and, in some cases, aquifers. Treatment plants for the estuary are not feasible; spot chemical treatment within an estuary, though useful, may have unpredictable side effects.

f. Decontamination and recovery

Social and economic, as well as ecological problems result from pollution at the interface zone. Enormous costs are frequently involved if decontamination or other corrective actions are decided upon by the political authorities. These may be prohibitive, so that for certain purposes the estuary is "abandoned", or it is decided to forgo its nurturing habitat roles as trade-offs for the benefits connected with housing, industry, port operations, waste disposal or some combination of these. We now realize that we cannot continue to disturb the interface without experiencing the consequences. The estuaries and associated areas are, thus, increasingly at the centre of disputes among conflicting interests. Physical clean up, purification plants and other pollution abatement measures are sometimes decided upon, however, when in a contest of values those favoring estuarine viability win out. Even so, serious difficulties often arise when the total price tag is known; projects often cannot be fully funded. It is then that regrets may be voiced to the effect that it would have been wiser and cheaper to have avoided the estuarine damage in the first place. It is also true that the estuarine zone possesses important natural recovery capacities, up to a point, particularly if the contaminant is biodegradable and the polluting event is a one time occurrence, as in the case of an oil spill. Continued discharges can only worsen the conditions within an estuary **72/**. The freshwater managers, not excluding sanitation men and public health authorities, have important roles to play if the estuarine environment is to be restored to viability. Concerted and coordinated collaboration is obviously necessary.

CHAPTER II - **INTERNATIONAL LAW**

A. **The Developing Law of the Sea**

Among the many notable developments in the field of the international law of the sea is the acceptance of the need to take concerted action to protect the marine environment **73/**. Guided by the findings of marine scientists, attention has focused heavily on "land-based sources" of marine pollution. These findings place new burdens on at least the littoral States with respect to the quality of their freshwater flows into the interface zone and, thus, eventually and partially into the open sea.

As Judge Manner said as early as 1960, emphasizing multinational enclosed seas and bays **74/**:

"... Where... the waters of a river, running into a sea, are polluted, the estuary may also be contaminated. Such secondary pollution is apparent in the estuaries of many big rivers on the continent of Europe...

...

"... The pollution of a sea may become of international legal significance where the territorial waters belong to contiguous or facing States, so that an activity with a polluting effect carried on in the territory of one State may contaminate the territorial sea of another...

...

"Clearly, in the marine domain a measure whose effect extends to the territory of another State is comparable to a measure affecting a river of lake which is part of boundary waters. In other words, in international law, the pollution of sea areas, situated within the territory of another State, must be regarded as a kind of interference which is, in principle, prohibited."

1. The 1982 Law of the Sea Convention

Full recognition of the problem is manifested in the 1982 United Nations Convention on the Law of the Sea **75/**. The product of years of multifaceted study and negotiation, the 1982 Convention in fact contains many specific provisions relevant to estuarine matters. The first article contains the following definition **76/**:

"'pollution of the marine environment' means the introduction by man, directly or indirectly, of substances or energy into the marine environment, **including estuaries**, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of **sea water** and reduction of amenities" (emphasis added).

It seems assumed in the definition that the water in estuaries is sea water, that is part of the sea, and therefore, subject directly to the law of the sea as part of the marine environment. The freshwater component of estuarine water is not acknowledged. Estuarine water is brackish water, a fluctuating mixture of riverine and marine water; estuaries, geomorphologically speaking, are variously shaped indentations in the land and, in whole or in part, situated behind (landward of) the final coastward limit of maritime jurisdiction, that is, behind the "base line" from which the seaward reach of the territorial sea, the contiguous zone and the exclusive economic zone are measured. Supposedly waters behind the base line are by definition not subject to the law of the sea. Only general international law principles applicable to sovereign State territory would be, applicable, and these are few and narrowly construed.

Generally, estuaries and other estuarine zones behind the base line are in law technically "internal waters", subject only to the jurisdiction of the coastal State. Also, they belong as much to the regime of fresh waters as they do to the regime of marine waters in physical, chemical and biological terms. Therefore, when the 1982 Convention expressly embraces estuaries as part of the marine environment (the only component singled out for special mention), all of its provisions on "pollution of the marine environment", as we shall see, clearly govern the pollution of estuaries. In short, the abovesaid Convention purports to be applicable directly, as it were, to those estuarine portions of a State's internal waters, which are fully and exclusively part of the territory of coastal States. But the sovereignty of a coastal State is acknowledged in the Convention to extend "beyond its land territory and internal waters and, in the case of an archipelagic State, its archipelagic waters to an adjacent belt of sea, described as the territorial sea" **77/**.

A number of other provisions affecting in other ways "internal" and onshore matters are prominent in the Convention. For example, the concerns expressed earlier in this study for diadromous species, which must twice pass through the estuary and frequently spend portions of their life cycle in that exceptional environment, are fully addressed in Articles 66 ("Anadromous stocks") and 67 ("Catadromous species") **78/**. States where the stocks originate are placed under a duty to "ensure their conservation", taking into account prior fishing by other States; attention to conditions in the estuarine habitat will, thus, be required **79/**. With respect to catadromous species, management responsibility is assigned to the coastal State in whose waters the species spend the greater part of their life cycle; "ingress and egress" of the fish when migrating is to be assured. Agreement on "rational management" among the interested States is mandated when the catadromous fish migrate through the exclusive economic zone of another State **80/**. "Highly migratory species", which indeed may visit the estuarine zone and even be caught there, are governed separately "with a view to ensuring conservation and promoting... optimum utilization" **81/**. But the Convention's principal stipulations impinging on States with an estuary-basin deal with pollution of the marine environment, as set forth above. This aspect obviously was given much weight by the treaty's drafters. States not only have, under the Convention, "the obligation to protect and preserve the marine environment" in general terms **82/**; rather specific provisions bring the duties close to the interface. Subsequent articles require, for example, "all measures consistent with this Convention necessary to prevent, reduce and control" pollution, "from any source..." **83/**. Moreover, "all measures necessary" shall be taken by States "to ensure... that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights" **84/**. States exercise sovereign rights behind the base line, which includes coastline zones.

The first of many specific references to marine pollution from land-based sources is in the Convention provision delineating measures that will "minimize to the fullest possible extent" "the release of toxic, harmful or noxious substances, especially those which are persistent..." **85/**.

Measures taken "shall include those necessary to protect and preserve **rare or fragile ecosystems** as well as the **habitat** of depleted, threatened or endangered species and other forms of marine life" **86/** (emphasis added). States must act "so as not to transfer... damage or hazards from one area to another or transform one type of pollution into another" **87/**. The prevention of the introduction of species, "alien or new, to a particular part of the **marine environment**" is required, if those "may cause significant and harmful changes thereto" **88/** (emphasis added).

Each of these provisions has rather direct bearing on estuarine zones. All States, not just the coastal States (at the terminus of the freshwater basin), are addressed by these articles. Global and, as appropriate, regional co-operation is mandated to these ends **89/**. In the event of imminent danger, or actual damage to the marine environment, the State that first becomes aware of the situation is under a duty to notify other States likely to be affected "as well as the competent international organizations" **90/**. A toxic spill, or other event, in the estuarine zone, or even up river, might well be of such a nature as to require the State where the spill occurred to notify other States. Co-operation in such an event among the States in the affected area, and with the "competent international organizations", is mandated; contingency plans are to be developed for such "pollution incidents" **91/**. Co-operation is also required among States to promote research programmes and to encourage information and data exchange about marine pollution **92/**. On the basis of the information and data acquired, States are obliged to co-operate to establish guidelines for the formulation of "rules, standards and recommended practices and procedures" for dealing with pollution of the marine environment **93/**, which includes, by definition, the estuaries.

The "risks or effects" of such pollution are to be observed, measured, evaluated and analyzed "by recognized scientific methods" **94/**. States are, moreover, under a duty to "keep under surveillance the effects of any activities which they permit or in which they engage" in order to ascertain whether pollution of the marine environment is likely **95/**. This is an international law duty with respect to a State's "sovereign" territory, including estuaries.

Thus, any aspects of the use and development of an estuary-basin will, assuming the entry into force of such provisions, have to be kept under scrutiny, and any indicated corrective action taken. In addition, if a State in the estuarine zone or an upstream State has "reasonable grounds for believing that planned activities" under its jurisdiction or control "may cause substantial pollution of or significant and harmful changes to the marine environment", the potential effects must be assessed and "reports of the results" communicated to the competent international organizations, which should make them available to all States **96/**.

Article 207 of the Convention is devoted to pollution from land-based sources **97/**:

"1. States **shall adopt laws and regulations to prevent, reduce and control** pollution of the marine environment **from land-based sources**, including **rivers, estuaries, pipelines and outfall structures**, taking into account internationally agreed rules, standards and recommended practices and procedures.

2. States shall **take other measures** as may be necessary to prevent, reduce and control such pollution.

3. States shall **endeavour to harmonize** their policies in this connection at the appropriate regional level.

4. States, acting especially through competent international organizations or diplomatic conference, shall **endeavour to establish global and regional rules, standards and recommended practices and procedures** to prevent, reduce and control pollution of the marine environment from **land-based sources**, taking into account characteristic regional features, the economic capacity of developing States and their need for economic development. Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.

5. Laws, regulations, measures, rules, standards and recommended practices and procedures referred to in paragraphs 1, 2, and 4 shall include those designed **to minimize, to the fullest extent possible, the release of toxic, harmful or noxious substances, especially those which are persistent**, into the marine environment" (emphasis added).

Because it has been shown that contaminating contributions to estuarine zones from atmospheric sources is significant, and in some instances or seasons predominant, the Convention's obligations relating to "pollution from or through the atmosphere" are likewise applicable as indicated in its Article 212, **98/**:

1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere, **applicable to the air space under their sovereignty** and to vessels flying their flag or vessels or aircraft of their registry, taking into account internationally agreed rules, standards and recommended practices and procedures and the safety of air navigation.

2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.

3. States, acting especially through competent international organizations or diplomatic conference, shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution." (emphasis added States are furthermore under a duty to take **enforcement** actions in connection with pollution from land-based sources, as well as from sea-bed activities **99/**.

Pollution from vessels is, of course, also covered. The provisions contemplate threats to "the coastline", as part of the "marine environment", as well as pollution damage to the "related interests" of coastal States **100/**; "States shall adopt laws and regulations for the prevention, reduction and control" of marine environment pollution **101/**. States also "shall establish international rules and standards" for those purposes, which should include rules and standards "relating to prompt notification to coastal States, whose coastline or related interests may be affected..." **102/**. The pollution-by-dumping provisions, and their enforcement in initial terms apply to the entire marine environment; however, the specific stipulations refer to dumping within the territorial sea and the exclusive economic zone and onto the continental shelf without reference to coasts or estuaries **103/**.

Under the Convention's "Responsibility and Liability" Section, States "shall be liable in accordance with international law" for failure to fulfill "their international obligations concerning the protection and preservation of the marine environment" **104/**. If damage is caused by pollution of the marine environment "by natural or juridical persons under their jurisdiction", States are obliged to ensure the availability of recourse "in accordance with their legal systems for prompt and adequate compensation or other relief" **105/**. There seems to be no reason to exclude States upstream in the basin of the estuary from the application of such provisions.

The above exposition of principles and potential legal obligations is intended to demonstrate the strong thrust of modern law of the sea thinking,

which obligations may not have been fully appreciated by some States. Some water resources specialists also may profit by these new marine law considerations.

2. Other international instruments for the control of land-based marine pollution

A number of conventions of regional import are specifically aimed at the prevention and control of marine pollution from land-based sources and are, as a result, of direct relevance to the protection of estuarial zones from land-based sources of pollution. These conventions cover, respectively, the North-East Atlantic, and the Baltic Sea. In addition, land-based marine pollution is covered in all the regional conventions on the protection of the sea from pollution which have been concluded under the aegis of the United Nations Environment Programme (UNEP) **106/**. However, only loosely binding obligations of principle have been incorporated in the text of these conventions. It is only with respect to the Mediterranean Sea and the South-East Pacific region that the respective States Party have undertaken more stringent obligations by adopting separate Protocols for the protection of the respective regional seas from land-based marine pollution. In addition, several Directives adopted by the European Economic Community in the field of water pollution control are directly or indirectly applicable to the estuarial zones of rivers. Finally, UNEP has issued Guidelines and Principles on the matter of marine pollution from land-based sources. These deserve attention in the framework of this review as the Guidelines provide a useful, albeit non-binding, reference for the framing of regional and domestic regulations for the control of marine pollution from land-based sources.

a. The North-East Atlantic Convention

The Convention for the Prevention of Marine Pollution from Land-Based Sources **107/** - also known as the Paris Convention - was concluded in 1974 for the protection of the North-East Atlantic and parts of the Arctic Sea. The geographical reach of the Convention expressly includes "waters on the landward side of the baselines from which the breadth of the territorial sea

is measured and extending in the case of watercourses ... up to the freshwater limit". This is defined in the Convention as "the place in the watercourse where, at low tide and in a period of low freshwater flow, there is an appreciable increase in salinity due to the presence of seawater (article 3). As a result, estuaries and deltas are well within the Convention's reach. In essence, under the terms of the Convention States Party to it are (a) to eliminate pollution from a number of black-listed substances within an agreed upon time frame, and (b) to curb pollution from a number of gray-listed substances through the introduction of waste discharge permits - including, in particular, permits for discharges into watercourses "affecting" the maritime area covered by the Convention (article 4).

b. The Baltic Sea Convention

A similar approach to that of the Paris Convention is reflected in the Convention on the Protection of the Marine Environment of the Baltic Sea Area **108/**, concluded also in 1974 - known also as the Helsinki Convention. This Convention deals with various sources of pollution, with particular attention given however to pollution from land based sources, probably as a result of high population densities all along the seaboard of relevant coastal States. While the Convention's reach stops short of the "internal waters" of States Party, these have nonetheless pledged in the Convention to "ensure that the purposes of the ... Convention will be obtained in these waters" also (article 4). Hence, estuaries - which are explicitly mentioned in the fourth preambular paragraph to the Convention as a vehicle of marine pollution -indirectly come within the purview of the Convention as targets and beneficiaries at the same time of the land-based marine pollution control mechanisms provided in it. These hinge on restraining discharges of certain nominated substances through a system of regionally harmonized waste discharge permits into the marine environment (article 6). To this end, goals and criteria for the controlled disposal of municipal sewage, industrial wastes, and cooling water from nuclear and other kinds of industrial plants have been also agreed to (Annex III to the Convention).

c. The Protocol for the Protection of the Mediterranean Sea from Land-based Marine Pollution

The 1976 Barcelona Convention for the Protection of the Mediterranean Sea against Pollution was complemented in 1980 by a separate Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources **109/**. The geographical reach of the Protocol extends to the internal waters of States Party, up to the freshwater limit in the case of watercourses (article 3). The freshwater limit is defined as "the place in watercourses where, at low tides and in a period of low freshwater flow, there is an appreciable increase in salinity due to the presence of seawater" (article 2). As a result, the estuarial and deltaic areas which dot the Mediterranean coastline unquestionably come within the purview of the Protocol. Control measures under it hinge on the elimination of black-listed substances, and on restricting releases of gray-listed substances. The former objective is to be attained through joint inter-State or separate programmes and measures, including, in particular, common emission standards and standards for use, in accordance with an agreed upon time frame for implementation (article 5). Control of gray-listed substances is to be attained mainly by means of waste discharge permit programmes (article 6).

d. The Protocol for the Protection of the South-East Pacific against Pollution from Land-Based Sources

The Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific expressly singles out estuaries as discrete component elements of the marine environment which the Convention seeks to protect (article 2). The Convention has been subsequently complemented by a Protocol dealing specifically with land-based sources of marine pollution **110/**. Significantly, the reach of the Protocol is the same as the Mediterranean Protocol dealing with land-based marine pollution - a definition of the term "freshwater limit", however, is not given (article I). As a result, estuarial zones are definitely protected under the Convention and Protocol. The protection mechanisms envisaged by the Protocol are patterned after the Mediterranean Sea Protocol - whith the difference that less cogent language is employed in the former as opposed to the latter

Protocol with regard to (a) the abatement and eventual elimination of a number of black-listed substances (article IV), and (b) the abatement of a number of gray-listed substances (article V).

e. Convention on Wetlands of International Importance Especially as Waterfowl Habitat **111/**.

This Convention provides that areas may be designated for inclusion in a list (the List of Wetlands of International Importance), and thereby receive special protection; such areas are limited to "wetlands," defined in Article 1 as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres." Article 2 of the Convention provides that the designated area may incorporate "riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water not deeper than six metres at low tide within the wetlands..." Under this broad definition, estuaries would be eligible for inclusion in the list.

Wetlands of international importance to waterfowl are to be included in the list, and other areas may also be included "on account of their international significance in terms of ecology, botany, zoology, limnology or hydrology". (Article 2) Thus, protection pursuant to the Convention is by no means restricted to wetlands that support waterfowl, but extends to all wetlands of "international significance." Parties to the Convention are obligated to promote the conservation of wetlands included in the list and the wise use of wetlands in their territory, whether or not on the list (Article 3), and to establish nature reserves on wetlands and provide adequately for their wardening (Article 4). Contracting parties are expected to encourage research and exchange information, and to consult with each other, particularly in the case of a wetland extending over the territories of more than one party, or where a water system is shared by Contracting Parties (Article 5).

f. Directives of the Council of the European Communities

In 1976 the Council of the European Communities issued its first Directive on Pollution Caused by Certain Dangerous Substances Discharged into the Aquatic Environment of the Community **112/**. The Directive established List I, containing dangerous substances not permitted to be discharged, and List II, containing substances for which a prior discharge permit is required. The 1976 Directive applies to "inland surface waters, territorial waters, internal coastal waters and ground water." (Article 1) Inland surface water means "all static or flowing fresh surface water," while "internal coastal waters" means "waters on the landward side of the base line from which the breadth of territorial waters is measured, extending, in the case of watercourses, up to the freshwater limit." As in the Paris Convention, "freshwater limit" means "the place in the watercourse where, at low tide and in a period of low freshwater flow, there is an appreciable increase in salinity due to the presence of seawater." As a result, the 1976 Directive applies to estuaries, and obligates Member States to "take the appropriate steps to eliminate pollution of the waters [described above]...in accordance with this Directive, the provisions of which represent only a first step towards this goal." Subsequent Directives of the Council provided specific technical regulations with respect to certain substances; each subsequent Directive cites the 1976 Directive for the definition of the covered area **113/**.

In addition, the Directive on the Quality Required of Shellfish Waters **114/** is of immediate relevance since it specifically covers "coastal and brackish waters" (article 1). The water quality protection mechanisms envisaged in the Directive hinge on the designation by the Member States of waters in need of special protection on account of their supporting shellfish (article 1). As a result of designation, Member States are under an obligation to set limit values for the quality of designated waters in accordance with the parameters given in the Directive, and to attain them within a six-year time frame for compliance (articles 3, 5).

g. The UNEP Guidelines and Principles on Marine Pollution from Land-based Sources **115/**

The UNEP Guidelines and Principles on Marine Pollution from Land-based Soruces provide a fairly detailed frame of reference for the guidance of States in the framing of regional agreements and domestic legislation on this particular subject. The definition of the key terms "Marine environment" **116/** and "Freshwater limit" **117/** leaves little doubt that estuarine and deltaic zones come within the reach of the Guidelines. Relevant protection mechanisms hinge on the adoption and implementation by States of (a) "control strategies" patterned after the models offered in the Guidelines; (b) standards of marine water quality or emission standards, to be set on the basis of given criteria; and (c) action programmes aimed at eliminating pollution from black-listed substances, and curbing pollution from gray-listed substances (article 13).

B. The Developing International Water Resources Law

The water lawyers and the international lawyers, in dealing with water resources shared by two or more States, have until lately paid scant attention to the cases of shared, or international interface zones **118/**. Hydrologic interactions and interdependencies, phenomena so frequently emphasized with respect to surface waters and, now with groundwater, had not been extended to encompass estuaries **119/**.

1. The work of the International Law Commission

The codification and progressive development of international law relating to international watercourses has been on the agenda of the United Nations International Law Commission since 1974. As part of its work, the Commission has been preparing over several years and under four special Rapporteurs draft articles on the law of the non-navigational uses of international watercourses. By 1988, the present special Rapporteur had prepared an outline of the topic as a whole. The outline consists of seven parts: I) Introduction, II) General Principles, III) New Uses and Changes in Existing Uses, IV) Exchange of Data and Information, V) Environmental

Protection, Pollution and Related Matters, VI) Water-related Hazards and Dangers, and VII) Relationship between Non-navigational and Navigational Uses **120/**.

At its thirty-ninth session, in 1987, the Commission provisionally adopted Articles 2 to 7, which appear in parts I and II of the outline (Introduction and General Principles). The remainder of the draft articles is now before the Commission for consideration **121/**.

The draft articles apply to "watercourse systems;" the Commission's working hypothesis of what constitutes a "watercourse system" is contained in a note of understanding which provides that "a watercourse system is formed of hydrographic components such as rivers, lakes, canals, glaciers and groundwater constituting by virtue of their physical relationship a unitary whole" **122/**. It would seem that estuaries would be included in that working hypothesis, as constituting a unitary whole with rivers, canals, etc.

Part V of the draft articles, on Environmental Protection, Pollution, and Related Matters, submitted to the Commission at its 1988 session, consists of Articles 16 through 18. Article 16, on Pollution of International Watercourses, imposes general obligations on the parties to refrain from polluting international watercourses, and to consult with each other for the purpose of preparing lists of substances the introduction of which into the waters is to be prohibited, limited, investigated or monitored **123/**. Article 17, on Protection of the Environment of International Watercourses, provides in paragraph one that watercourse States shall take all reasonable measures to protect the environment of an international watercourse and shall, pursuant to paragraph two, take all measures necessary, including preventive, corrective and control measures, "to protect the marine environment, including estuarine areas and marine life" (emphasis added), from harm. The explanatory note to Article 17 provides that "it is also important to note that the obligatio set forth in paragraph two is separate from, and additional to, other obligations concerning pollution. For example, a watercourse state could conceivably endanger an estuarine area through pollution of an international watercourse without breaching its obligations not to cause appreciable pollution harm to other watercourse states or to the environment or ecology of the watercourse" **124/**. Article

18, on Pollution or Environmental Emergencies, obligates contracting parties to notify all potentially affected watercourse States of any incident which results in a pollution or environmental emergency.

In 1989, the Commission considered part VI of the draft articles, pertaining to Water-related Hazards, Dangers and Emergency Situations, consisting of Articles 22 and 23. Article 22, on Water-Related Hazards, Harmful Conditions and Other Adverse Effects **125/**, obligates parties to cooperate in order to prevent or mitigate water-related hazards such as floods, ice conditions, drainage problems, flow obstructions, siltation, erosion, salt-water intrusion, drought and desertification. Article 23, on Water-Related Dangers and Emergency Situations, also considered by the Commission, obligates parties to notify one another of any water-related danger or emergency, either natural or caused by human activities, and to cooperate in eliminating the causes and effects of the danger.

2. Other intergovernmental action

The problems of the estuarine zone are now well recognized in Europe. As early as 1970, Finland's initiative in the United Nations General Assembly, which resulted in the assignment of the international watercourses topic to the International Law Commission, pointed out in that connection the growing problems caused by coastal and marine pollution **126/**. Awareness has been growing among developing countries because of that and other initiatives within international organizations.

The Draft Principles prepared by the UNEP Intergovernmental Working Group of Experts on Natural Resources Shared by Two or more States are too well known, and at too high a level of generality, to merit reproduction here **127/**. Nonetheless, these "guidelines" express the manifest concern worldwide for "conservation and harmonious utilization of natural resources shared by two or more States" **128/**.

The United Nations General Assembly itself, in adopting the Charter of Economic Rights and Duties of States in 1974, addressed the exploitation of shared natural resources in these terms: "... each State must cooperate on

the basis of a system of information and prior consultations in order to achieve optimum use of such resources without causing damage to the legitimate interest of others" **129/**. Because the estuary of an international watercourse can be so polluted or otherwise so altered as to deny an upstream State of, for example, its anadromous fishery or its accustomed navigation, this rule would apply. "Others" whose "legitimate interests" could be damaged include neighbouring States whose coastal lands or waters are adversely affected, and States fishing in waters for species harmed by estuarine conditions **130/**.

In addition, several bilateral or multilateral conventions are in place for the purpose of combating pollution of various international rivers. Of these, only a few agreements specifically contemplate estuaries or are directly applicable to estuarial zones. Where estuaries are not mentioned, however, protection afforded the rivers indirectly accrues to the estuary, as the estuary will eventually receive waters that are less polluted. The following are significant examples of agreements of direct relevance to the estuarial zone of watercourses.

a. Rhine Conventions

In December, 1976, States through whose territory flows the Rhine River concluded a Convention on the Protection of the Rhine Against Chemical Pollution and a Convention on the Protection of the Rhine Against Pollution by Chlorides **131/**. The preamble of the Chemical Pollution Convention refers to the 1976 Directive of the Council of the European Communities, which, as discussed above, specifically includes estuaries in its coverage. Annex A of the Chemical Pollution Convention provides that "the Rhine begins at the outlet from the lower lake and includes its branches up to the coastline, from which its waters flow freely into the North Sea, and includes the Ijssel up to Kampen." The Convention contemplates the entire river course, including the point at which the fresh water of the river flows into marine waters. The Chemical Pollution Convention obligates the parties to eliminate pollution from certain substances (listed in Annex I) and to reduce pollution from certain other substances (listed in Annex II) **132/**. Measuring and reporting obligations are also imposed by the Convention, and an International Commission is established to monitor and coordinate activities under the Convention **133/**.

The Chloride Pollution Convention provides, in Annex A, that "the Rhine begins at the outlet from the lower lake and includes the branches of the river up to the freshwater limit from which its waters flow freely into the North Sea, including the Ijssel up to Kampen." "Freshwater limit," as in the Paris Convention, is "the area where at low tide and at a time when the discharge of fresh water is low, a sizeable increase in the chloride content is noted owing to the presence of sea water." Thus, the Chloride Pollution Convention would also apply to the estuary; its terms of coverage are even more explicit on this point than the Chemical Pollution Convention. Article 2 of the Chloride Pollution Convention obligates the parties, particularly the French Government, to control the discharge of chloride ions, with the objective of reducing such discharge by at least 60 kilogrammes annually on average. The Convention contemplates the installation of an injection system in the subsoil of Alsace in order to reduce over a period of ten years the discharges from the Alsace Potash Mines. The French Government is to report regularly to the Convention's International Commission, and parties to the Convention contribute to the cost of the injection project. All contracting parties undertake to prevent an increase in the amount of chloride ions already present in the Rhine, as shown in Annex II to the Convention, and to periodically measure the concentration of chloride ions **134/**. In December, 1986, the French Government officially announced to its partners that the injection project provided for in the Convention was not feasible, and that temporary storage of chloride residues on land would instead be effectuated. This would permit a reduction in the discharge of chlorides by 20 kilogrammes during the first phase of implementation. This plan has been officially accepted by the other parties to the Convention **135/**.

b. Rio de la Plata Conventions

The Rio de la Plata is actually an estuary, rather than a river, found at the convergence of the Uruguay and Parana rivers, between the borders of Argentina and Uruguay. In 1973, Argentina and Uruguay entered into a Treaty Concerning the La Plata River which defines the rights and obligations of the parties with respect to the Rio de la Plata **136/**. Chapters 1-8 of the treaty establish jurisdictional boundaries, provide for

freedom of navigation, address pilotage issues, port facilities, safety of human life, salvage, exploitation of the riverbed and jurisdiction over islands.

Chapter 9 deals with pollution, and Article 47 thereof provides that pollution includes "the direct or indirect introduction by man into the aquatic environment of matter or energy which may cause noxious effects." The parties undertake, in Article 48, to "protect and preserve aquatic resources, and particularly to prevent their contamination" by "issuing rules and adopting appropriate measures pursuant to applicable international conventions." The parties also undertake, pursuant to Article 49, not to diminish, through national legislation, existing requirements for the prevention of pollution or the severity of penalties stipulated for cases of violation. The parties undertake to inform each other as to any norms they expect to adopt with respect to water pollution (Article 50), and agree that each shall be liable for detriment suffered as a consequence of pollution caused by the other's operations, or by operations of persons domiciled on its soil (Article 51). The parties establish an Administrative Commission, which is responsible for the promotion of joint studies and research, with special reference to the prevention and elimination of pollution that may derive from the use of the river water (Article 66).

In addition to the bilateral treaty, a multilateral treaty of the River Plate Basin was signed in 1969 by Brazil, Paraguay, Argentina, Uruguay, and Bolivia **137/**. The parties' intention, as described in Article 1, is to promote the harmonious development and integration of the River Plate Basin "and its zones of direct and measurable influence." To that end, the parties agree to carry out studies, plans and works in order to achieve, among other things, "the rational utilization of water resources, in particular by the regulation of watercourses and their multipurpose and equitable development."

c. Colorado River

The Colorado river crosses the border between the United States and Mexico and empties into the Gulf of California near the border. The United States and Mexico have concluded several agreements to fix boundaries and to

manage rivers that flow between the two countries. In particular, the Agreement on Cooperation for the Protection and Improvement of the Environment in the Border Area **138/** concluded in 1983, applies to the "border area" defined in Article 4 as "the area situated 100 kilometers on either side of the inland and maritime boundaries between the Parties." As a result of the fact that the Colorado River empties into the Gulf of California some 20 kilometres South of the United States-Mexico international border, its estuary comes within the purview of the Agreement. The objective of the 1983 Agreement is to establish a basis for cooperation, and to provide the framework for development of a system of notification for emergency situations (Article 1). The parties undertake to adopt appropriate measures to prevent, reduce and eliminate sources of pollution in their territories which affect the border area of the other (Article 2), to coordinate their efforts in addressing air, land and water pollution in the border area (Articles 5 and 6), and to assess projects that may affect the environment in the border area in order to avoid or mitigate adverse environmental effects (Article 7). In 1985, the parties signed two annexes to the 1983 Agreement addressing more specific environmental issues in the border area. Under the terms of the second annex, Agreement of Cooperation Regarding Pollution of the Environment Along the Inland International Boundary by Discharges of Hazardous Substances **139/**, the parties agree to establish, pursuant to Article 2, a "joint contingency plan" to provide cooperative measures to deal with pollution incidents. Appendices to the Annex elaborate the joint contingency plan and establish procedures to be followed in the event of an incident.

3. Nongovernmental contributions

In the development of international water resources law (non-marine), the private professional organizations have been very active, incorporating State practice, the experience of international water resources managers, and the results of doctrinal studies worldwide **140/**. Yet, few of the professional efforts, official and unofficial, reported perceive the importance of the estuarine connection in international water resources law.

For example, the International Law Association's well-known Helsinki Rules define the international drainage basin in terms of the "watershed limits of the system of waters" **141/**, which is probably broad enough to embrace all deltas and some estuaries, but the **bottom** of the basin was in fact not considered by the drafters. The waters from this watershed are those "**flowing into** a common terminus" **142/**. There is not even implicit inclusion of the **terminus** itself, that is the estuary, or estuarine zone. And where does the "river" stop and the "terminus" begin?

As is well known, the point at which the river debouches into the sea cannot be said to be a precise, static place or line. The two water types flow over and under each other along a wide area, only ultimately mixing. Even the zone of mixing shifts with the tides and varying stream flow. In the case of very strong rivers, for example the Amazon, river water dominates for many miles into the ocean, far beyond the physical delta-estuary; where tides are minimal, such as in the Baltic, other conditions prevail. In some instances, for example the Gambia river, seawater dominates many miles upriver, especially during the dry season. A static concept of the "terminus" is simply not tenable. And what transpires in that "terminus" may well constitute the most important reasons for regulation of the uses of the waters. At the time the Helsinki Rules were drawn up, with what was then the most complete vision (for example, groundwaters were included for the first time), the interface problems had not come to the attention of the water law or the international law communities.

Post-Helsinki, however, the International Law Association's successor Committee produced the earliest statement of the estuarine problems in terms of legal rules. And in 1972 the Association adopted the Committee's articles on Marine Pollution of Continental Origin **143/**. The conduct said to be regulated internationally included, "**inter alia**, the discharge or introduction of substances into the sea from pipelines, extended outlets, or ships, or indirectly through rivers or other watercourses whether natural or artificial, or through atmospheric fall-out" **144/**. In establishing "seawater pollution" standards, the relevant factors were determined to include **145/**:

- the geography and hydrography of the area (inland waters, territorial sea, contiguous zone and continental shelf);
- climatological conditions;
- quality and composition of affected sea waters;
- the conservation of the maritime environment (flora and fauna);
- the sources of the sea-bed and the subsoil and their economic value for present and potential users;
- the recreational facilities of the coastal area;
- the past, present and future utilization of the coastal area and sea water;
- the economic and social needs of the (coastal) States involved;
- the existence of alternative means for waste disposal;
- the adaptation of detrimental changes to beneficial human uses;
- the avoidance of unnecessary waste-disposal.

The interactions between water resources, other natural resources and the environment are the subject of two general articles adopted by the Association in 1980, although specific constituents, such as the estuarine zone, are not identified **146/**.

The Institute of International Law and the Inter-American Bar Association, long active in the development of international water resources law, have not yet taken up directly the marine-facing facets of the field **147/**. However, the Institute's Rapporteur on "the pollution of international rivers and lakes," M.J. Salmon, declared that in the course of his work:

> "it became clear that pollution of the sea from sources on land was also transboundary pollution caused by rivers or lakes which it would be quite arbitrary not to deal with. Furthermore, the concern for protection of the environment as such - truly the heritage of mankind - which was now predominant throughout the world had even led the Commission to wonder whether States should not be required to see to the protection of their waters in their own territory" **148/**.

CHAPTER III - **THE DEVELOPING NATIONAL LAW**

A. **Environmental protection and pollution control**

General environmental protection legislation, and special anti-pollution legislation, frequently elaborate and all-embracing at a high level of generality, have now been enacted by a large number of States. The direct discharge of wastes into coastal waters is now widely regulated. The means of monitoring and enforcement are still often lacking, however. And legislation responsive to the specific environmental problems presented in the interface zone is still incomplete. Attention has been given to inland waters, offshore conditions including the deep sea, and to coastal waters generally, but often not specially to estuaries and deltas.

The British Control of Pollution Act, 1974 **149/** provides for criminal liability in respect of any person who discharges polluting matter into any river, watercourse or inland water, the sea within three nautical miles from any point on the coast measured from low-water mark of ordinary spring tides, and any other tidal water. Comparable restrictions apply to the discharging of trade or sewage effluents, including discharges from land through a pipe into the sea outside the three-mile limit. As a result, estuarine zones, and the coastlines adjacent to rivermouths are well within the scope of the Act. Liability under these provisions is subject to defenses, basically where the discharge is made pursuant to a disposal license or consent, or in accordance with "good agricultural practice" **150/**.

Where it appears that pollution injurious to the fauna or flora of a stream has been caused in consequence of discharges made pursuant to a consent granted by the appropriate Regional Water Authority, the Authority must revoke or alter the terms of the consent, and must carry out such operations as are necessary to restore the fauna and flora of the stream to the state in which they were immediately before the polluting discharge. The Authority may, however, recover the relevant costs from the polluter.

Although the Act received Royal Assent on July 31, 1974, it was not until July 1984 that the Minister of the Environment announced the phased introduction of the main body of Part II of the Act. This delay was due primarily to the fear of the cost involved in implementing the Act, both to industry and to the ten Regional Water Authorities, which as administrators of sewage disposal had become the biggest potential source of pollution **151/**. In order to ease the transition to full implementation, in 1983 regulations were issued **152/** which exempted from the Act's consent requirements certain discharges (trade or sewer effluents to controlled waters, or through a pipe to the sea outside three nautical miles and discharges of matter from a sewer or drain) which were begun on or before April 30, 1974. Certain substances were not eligible for the exemption, however, as was also the Mersey estuary (i.e. the Act was effective with respect to certain substances and for the Mersey estuary). In addition to these exemptions, the 1983 regulations provided that discharges which had begun prior to 1974 and which had not been exempted were deemed to be authorized even in the absence of a positive determination by the Water Authority. Deemed consents also apply to certain pre-1951 discharges, and to discharges made pursuant to a consent under previous legislation.

In October 1986, the exemptions provided by the 1983 regulations were lifted, and deemed consents would be replaced, over a five year period, by a consent that has been duly considered and awarded by the appropriate Water Authority **153/**. As a result, means of protecting the estuaries under the 1974 Control of Pollution Act have only recently become available in fact.

In the United States, the Federal Water Pollution Control Act Amendments, also known as the Clean Water Act, were enacted in 1972, as amending legislation to the earlier Water Quality Act of 1965 **154/**. Title I of the Clean Water Act, on Research and Related Programs, requires the Administrator of the Environmental Protection Agency (EPA) to conduct and promote studies of the effects of pollution, including sedimentation, in the estuaries and estuarine zones of the United States, to thoroughly investigate the condition of estuaries and estuarine zones and to identify the problems and areas where further research is required, and to report his findings to Congress at least once every three years **155/**. "Estuarine zones" is defined

in the Act as "an environmental system consisting of an estuary and those transitional areas which are consistently influenced or affected by water from an estuary such as, but not limited to, salt marshes, coastal and intertidal areas, bays, harbors, lagoons, inshore waters, and channels." "Estuary" means "all or part of the mouth of a river or stream or other body of water having unimpaired natural connection with open sea and with which the sea water is measurably diluted with fresh water derived from land drainage" **156/**.

To the extent that estuaries may be made to come under the notion of "navigable waters", the Clean Water Act's permit requirements for discharges from industrial sources of pollution and from public sewage treatment plants afford protection to the water resources in the estuarine zone. In addition, the permit requirements in effect for the disposal of dredge and fill material may restrain the conversion of wetlands for human settlement **157/**.

Specific concern for the estuarine zone is reflected in the 1987 amendments to the Clean Water Act, which, inter alia, established the National Estuary Programme. The Programme is designed to identify significant estuaries that are threatened by pollution, promote comprehensive planning, conservation and management of such estuaries, encourage the preparation of management plans for such estuaries, and enhance the coordination of estuarine research. The Programme contemplates, with respect to a given estuary, the organization of a conference including the EPA Administrator and the representatives of each state located in the estuarine zone (or entities having jurisdiction over the area), affected industries and interested Federal agencies, as determined by the Administrator. The conference is to then assess the condition of the estuary, and formulate a conservation and management plan. The period of the conference is not to exceed five years. Upon approval of the plan, implementation may be effectuated using funds authorized under specific provisions of the Clean Water Act and grants awarded by the Administrator. Finally, research programmes and reports pertaining to estuarine zones in cooperation with certain other Federal agencies are required **158/**.

The provisions of the Emergency Wetlands Resources Act, 1986 could conceivably be invoked for estuarine resources conservation purposes. The statute was enacted to promote the conservation of migratory waterfowl and to offset or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitat **159/**. Under the Act, "wetland" means land that is inundated or saturated by surface or groundwater sufficient to support a prevalence of plants growing in water or soil that is deficient in oxygen as a result of excessive water content **160/**. The Act extends previous legislation pertaining to loans to promote the acquisition of wetlands, and authorizes the Secretary of the Interior to raise funds for the conservation of wetlands. The Secretary is also required to establish a list of the types of wetlands that should receive priority for Federal and State acquisition, to produce an inventory of wetlands and maps thereof, and to report to Congress.

In Sri Lanka, the Marine Pollution Prevention Act, No. 59 of 1981 was enacted to provide for the prevention, reduction and control of pollution in "Sri Lanka waters." "Sri Lanka waters" include "the territorial sea, the contiguous zone, the exclusive economic zone, the continental shelf and the pollution prevention zone, as defined in the Maritime Zones Law no. 22 of 1976" **161/**. Although estuaries are not specifically included in "Sri Lanka waters" Part III of the Act provides for civil liability for polluting "the foreshore or any interests related thereto." These include "the marine, coastal, port or estuary activities including fishery activities" **162/**. The emphasis of the Sri Lankan statute is, therefore, on the economic activities sustained by the estuary, rather than on the estuary per se.

Colombia has a comprehensive national code **163/** which serves as a general legal framework for the protection and rational use of the State's natural renewable resources, including land and water. Pursuant to this code, the deltas, estuaries, wetlands, and lagoons, among others, belong to the State **164/**. Acts which degrade the environment, and are prohibited, include the pollution of waters and any change in the sedimentation of waterways. Title VI of the code regulates the use, conservation and preservation of the waters generally, and provides, among other things, for the regulation of discharges of industrial effluents **165/**.

In Venezuela, the National Environment Act provides that environmental protection includes the rational management of rivers and natural marine and inland resources **166/**. The law provides for the formulation of a national environmental protection plan, and enumerates a number of acts that may be regulated or limited pursuant to the national plan, because they directly or indirectly degrade the environment **167/**. Those acts include any change in watercourse sedimentation or in river basins, introduction of solid wastes and liquid wastes in the waters, and any other activity capable of changing the ecosystem in the national territory **168/**.

B. Estuarine Sanctuaries and other protected areas

In some countries, one response to the multiple threats to the estuarine environment has been to establish special preserves embracing areas identified as "critical habitats" for intertidal life, or to protect selected estuaries or deltas from development. Sometimes the special reserves are designated as "marine parks" or wildlife sanctuaries. The designation of space as a marine park is a first and vitally important step. Policing the human activities that impinge on such reserves has proven to be more difficult. Ensuring delivery of uncontaminated water to the park has been a problem in some cases, since these parks lie at the bottom of the drainage basin rather than at or near the top. Therefore, agricultural and industrial practices and sewage disposal, for example, must be controlled upstream for the benefit of the preserve. Last but not least, the quantities of water needed at different times in the sanctuary may require a river regulation regime different from that which optimizes established uses. Particularly onerous decisions will be called for during periods of drought.

Critical estuarine habitats are still to be found in remote or relatively undeveloped regions. Before human habitation and water use damage the habitat or make guaranteed water supplies impractical, or the genetic resources become substantially impaired, estuarine preserves should be carefully selected and provided for. In many deltaic, marsh and alluvial plains areas, the natural vegetation has been largely cleared for cultivation. These areas are, nonetheless, now recognized as biotic survival zones. This is, for example, the situation in the Ganges-Brahmaputra-Meghna

delta; some natural forests remain in that zone, mostly in the deltaic swamps of the Sunderbans, as well as in the hilly regions. Under Bangladesh's Wildlife (Preservation) Act of 1973, at least the Sunderbans Wildlife Sanctuary (covering a mangrove area) and Himchary National Parks (on the Tekmaf Peninsula) have been designated as reserves. Special studies and protection of the estuarine processes are now possible **169/**.

In the United States a National Marine Sanctuaries Programme has been established in the Office of Coastal Zone Management. Considerable attention is being directed toward the protection of selected estuarine and ocean resources from the ill effects of development. The Secretary of Commerce has been charged with the identification of sanctuary sites where development appears imminent **170/**. There are already in operation many wildlife refuges, especially sanctuaries for migratory and shore birds in estuarine zones; other wildlife enjoy some protection and attention even where the protection of waterfowl habitat was the original or central purpose of the reservation **171/**. In the United States, marine sanctuaries are not the same as estuarine sanctuaries, which are designated for part or all of an estuary together with adjoing "transitional areas" ad uplands adjacent to these. Site selection and operation of marine sanctuaries may, however, complement a sanctuary established for an estuary, since under the Coastal Zone Management Act, the protection of representative estuarine ecosystems for research is a major objective. The marine sanctuary programme, patterned after the land wilderness system, is designed to identify and safeguard critical habitats and zones containing superlative recreational or natural visual features. Balancing use of the areas - including future extractive and industrial uses - with protection values is the management challenge, necessitating special legislation and institutional authority comprehending the freshwater drainage basin and associated marine phases, as well as the estuary or delta proper. The basic policy is to accommodate commercial and sport fishing, gas and oil exploration and production, and recreation under specific limitations.

In Italy, regional law no. 53 of 1983 mandates protection of the Po River delta. The law contemplates the development of a comprehensive environmental protection plan and the creation of parks and nature reserves, and requires that all development projects be compatible with protection of the environment **172/**.

In addition to the examples for far discussed, in a few countries movements are underway to to preserve what are usually called "wild and scenic rivers". In the United States, for example, legislation was passed in 1968, enablig Congress or the States to designate wild and scenic rivers for inclusion in the national wild and scenic rivers system **173/**. In New Zealand, national water conservation orders may be made to protect the natural state of rivers, streams or lakes, or parts thereof and to protect relevant "outstanding recreational, fisheries, wildlife, habitats, scientific, or other feature" of streams or sections thereof. Conservation orders basically protect instream values by restricting the power of the responsible government authorities to grant water rights - including, in particular, the right to dam a stream **174/**. Other countries are certain to follow as threats to their remaining upland wilderness areas become more apparent. The designation of free-running and unspoiled watercourses will allow their preservation for future generations and for research purposes. This relatively new concept is a wise extension of the conservation movement. The basically "up-river" outlook of this trend is clear, as the opposite - the "seaward" view - is still evident in a few of the marine habitat situations. True, a "wild river" may be only a tributary of a larger river, or only an upper portion of the latter. Nonetheless, the preservation measures realized in a "wild and scenic river" reserve, or the failure to take certain measures having value downstream, will have their impact in the estuarine zone **175/**. Authorities charged with coastal zone conservation and those responsible for interior watershed reservations should coordinate their efforts to the best advantage of the entire drainage.

C. Coastal resources development and conservation

A number of countries have enacted in recent years a series of laws pertaining broadly to coastal zones. These have been prompted chiefly by awareness of actual environmental degradation, or by the clear threat of such degradation.

The legislation of the United States, for example, has issued from both State legislatures and the national Congress. The 1972 Coastal Zone Management Act (CZMA) **176/** deals with the estuaries and the coastal areas of

the United States. The CZMA was enacted to protect the coastal zone from damage caused by poorly planned development, chiefly through state-developed, federally-approved coastal zone management programmes. "Coastal zone" includes "islands, transitional and intertidal areas, salt marshes, wetlands and beaches." "Coastal waters" means, among others, "those waters, adjacent to the shorelines, which contain a measurable quantity or percentage of sea water, including, but not limited to, sounds, bays, lagoons, bayous, ponds, and estuaries" **177/**. The term "estuary" means "that part of a river or stream or other body of water having unimpaired connection with the open sea, where the sea water is measurably diluted with fresh water derived from land drainage" **178/**. Federal grants are available to assist states in developing management programmes. Once the Federal government has approved a State Management Plan, the Federal activities or development projects in or affecting a State's coastal zone must be consistent with the State's management programme **179/**.

One issue particularly has come to the fore in reconciling the CZMA with other, overlapping legislation: how to assure that offshore petroleum exploration and production permits (leases), issued by the Federal Government under the Outer Continental Shelf Lands Act (OCSLA) **180/** are not violative of a State's programme under the CZMA. OCSLA deals with offshore oil and gas development. While such "outer" continental shelf activities would be expected to occur ordinarily beyond any seaward limits of the interface, the impacts on the estuarine zone of, inter alia, onshore support facilities, pipeline installations, leaks and any spills, and transportation to and from drilling platforms are direct. Spills or dumping, and disposal of water extracted from oil and gas wells, if brought to shore by current or wave action, are also to be reckoned with. But there is a concerted drive to develop energy sources, in pursuit of which OCSLA policy was enacted. Policy conflicts of this kind have not been fully resolved. The debate and the struggle may prove instructive to other countries facing analogous problems.

Consistent with the Coastal Zone Management Act of 1972 is the Louisiana State and Local Coastal Resources Management Act of 1978 **181/**. The main purpose of the Louisiana statute is to protect, develop, and, where feasible restore and enhance the resources of the State's coastal zone **182/**.

It is interesting to note that the Louisiana coastal zone contains 40 percent of the country's wetlands. Formed by the nation's largest river, the Mississippi, which drains 40 percent of the 48 contiguous states plus significant areas of several Canadian provinces, it is far and away the largest and most active deltaic land mass in North America. The Louisiana State and Local Coastal Management Programme envisages two types of uses of the coastal zone. Uses of State concern are those which directly and significantly affect interests of a region, the State or the Nation. These are mainly projects involving use of State-owned lands and water bottom (estuaries and deltas included), and projects involving minerals **183/**. Uses of local concern are "those which affect coastal waters and are in need of coastal management, but should be regulated primarily at the local level" **184/**. All these uses of coastal zone resources are subject to permit requirements in the interest of resolving resource use conflicts. The Secretary of the Louisiana Coastal Management Programme develops, administers, and monitors the overall State coastal management programme in conjunction with the Secretary of the Department of Wildlife and Fisheries. Local coastal management programmes may also be developed, in accordance with guidelines set forth by the Secretary.

Louisiana has also enacted legislation pertaining to waterbottom management. Pursuant to the Act, the Louisiana Department of Natural Resources is responsible for the control, permitting and leasing of encroachments upon public lands **185/**. "Public lands" are defined in the Act to include "the beds and bottoms of all navigable waters and the banks or shores of bays, arms of the sea, the Gulf of Mexico, navigable lakes, that shall be protected, administered and conserved to best insure full public navigation, fishery, recreation and other interests" **186/**.

In the state of Georgia, the state's Game and Fish Code and other earlier enactments have been supplemented with the Coastal Marshlands Protection Act of 1979. Activities in the state's coastal area now require permits, for example, for any tidal marsh alteration. Georgia's estuarine zone is protected by a series of barrier islands which have been subjected to intensive recreational activities and it was deemed necessary to declare "that the coastal sand dunes, beaches, sandbars, and shoals comprise a vital

natural resource system, known as the sand sharing system, which acts as a buffer to protect... property from the damaging effects of floods, winds, tides, and erosion." Further, "that the sand sharing system is an integral part of Georgia's barrier islands, providing great protection to the state's marshlands and estuaries" **187/**.

The Virginia Wetlands Act was enacted in 1972 to preserve wetlands, to prevent their despoliation and destruction, and to accommodate necessary economic development in a manner consistent with wetlands preservation **188/**. Pursuant to the Act, the Marine Resources Commission is to establish guidelines which evaluate wetlands, and set forth the consequences of use of wetlands. A wetlands zoning ordinance is set out in the Act, which counties, cities, and towns are authorized to adopt.

One development of note in the United States generally is the revival of the ancient "public trust doctrine" with respect to estuarine waters. The concept may be derived from Roman law, which regarded navigable coastal waters, and the beds thereof up to the line of high water, as reserved for the common benefit of all citizens **189/**. This concept in the common Law held that tidewaters and their submerged lands belonged to the King to be used for navigation, fishing and commerce **190/**. Early U.S. Supreme Court decisions for reasons not here germane found stated that "public trust" had passed to the individual states of the Union **191/**. Consequently, ownership and jurisdiction over these waters are fundamentally with the states; the Federal Government has, nonetheless, supreme power delegated to it to regulate interstate and foreign commerce, and under modern decisions, "commerce" is very broadly construed **192/**.

In Sri Lanka, the Coastal Conservation Act No. 57 of 1981 called for the preparation of a Coastal Management Plan, based on, inter alia, an inventory of all estuarine or wetland areas within the coastal zone, with an indication of their significance as fisheries or wildlife habitat. A director of Coastal Conservation is in charge of preparing the Plan. Further, the Director has the power within the Coastal Zone Plan to make proposals for the reservation of land or water for certain uses and to forbid activities in areas of the coastal zone which are detrimental to the ecology of the wetland

estuaries and deltas. Finally, he may issue regulations directed toward the use of the coastal zone by members of the public. Where the Director finds that the quality of the water in the Coastal Zone, or the stability of the Coastal Zone has been adversely affected by the intrusion of any waste or foreign matter or by physical activity, he may a) order the person responsible to take corrective measures in the Coastal Zone; b) if such activity is not in the Coastal Zone, request the appropriate local authority or agency to take the corrective measures **193/**.

In France, an Act for the Management, Protection and Development of the Seashore was enacted in 1986 to regulate and conserve coastal resources. The law provides that the most important rivers and estuaries may be designated by decree for inclusion in a list. Areas to be so designated are those that are unusual or characteristic of the natural and cultural heritage, and would include, for example, unspoiled estuaries. With respect to areas included in the list, the law requires that planning and building activities conform to a management plan. In any event, no construction is permitted along any French seashore within 100 meters of the high-tide mark; with limited exceptions, new roads must be located not less than 2,000 meters from the shore **194/**.

It perhaps is in regard to fisheries regulation that national laws have around the world, shown the keenest awareness of the importance of estuaries. And where there are valuable fisheries of diadromous stocks, the scope of policy, if not of effective regulation, comprehends the entire habitat within national jurisdiction which may extend, for example, from small remote spawning rivulets in North America or Europe to migration routes through marine fishing or economic zones to vast gyres off southern Greenland–but always by way of the estuary.

A good example of modern fisheries legislation is Malaysia's 1985 Fisheries Act **195/**. "Estuarine waters" are there defined to mean "water extending from the mouth of a river (a) up to the point upstream penetrated by sea water at neap tides..." **196/**. Although the landward delimitation of this definition is adequate for purposes of dividing estuarine fisheries from riverine fisheries, its seaward bounds ("mouth of a river") is entirely inadequate. "Riverine waters" are defined in the Act to be any waters other

than estuarine and maritime waters **197/**. The lower reaches of a river (above the estuary proper) would thus not be "riverine" since by definition they would be "estuarine." But at least the concept of estuarine waters–beyond the waters for the moment in the "bowl" or receptacle at the extreme bottom of the drainage basin–is accepted. "Maritime waters" in the Act are "the seas adjacent to Malaysia, both within and outside Malaysian fisheries waters, and includes estuarine waters..." **198/**. In short, fisheries are considered maritime if operated seaward from the baseline used to measure the territorial waters. Behind the baseline, fisheries would presumably be estuarine **199/**. Such simplified formulas may appeal to the uninformed, and be necessary still at the international level, but within one nation's jurisdiction, bounds and jurisdiction need not follow criteria insensitive to the realities of the fisheries involved. At any rate, estuarine fishing was joined with maritime fishing for purposes of regulatory authority. For the finfish fisheries such a classification is appropriate; however, for fish cultivation a special focus on the estuary is critical. Even in the impoundments within estuaries where freshwater enters, specific salinity levels must be maintained, and flooding must be prevented; for example, the control of temperature and of disease organisms is also critical. The returns on investment can be high, but only if the environment can be closely managed. Perhaps understandably, given the climactic conditions of Malaysia and the lack of large rivers and anadromous species, no concern is shown for the conditions in estuarine waters **200/**.

Expanded aquaculture investment and production, as well as the existing inshore marine fisheries, justify more specific attention to water quality, deposit of sediments, and alterations in the estuarine zone. In short, the preservation of that food chain is of such concern that pertinent specific provisions should appear in the fisheries legislation even though, as is the usual case, general prohibitions and criteria may be in the environmental legislation. Above all, perhaps, "riverine" water resources legislation must enlist the collaboration of water using ministries and private persons; the economic and social value of upstream projects must be weighed in advance of execution against any estuarine detriment, especially to the aquaculture potential and to other fisheries.

In the United States, the Anadromous Fish Conservation Act of 1965 did direct the Secretary of the Interior, on the basis of the studies conducted under the Act **201/** to make formal recommendations for the

> "elimination or reduction of polluting substances detrimental to fish and wildlife ... Such recommendations and any enforcement measures initiated pursuant thereto ... shall be designed to enhance the quality of such waters, and shall take into consideration all other legitimate uses of such waters." **202/**.

D. Conclusions

In summary, most States, individually and in their relations with other States, are still struggling with their legal regimes and institutional machinery for coping with their water resources and environmental concerns, offshore, inshore and onland. The areas draining into deltas, estuaries and wetlands are of prime importance in the total picture but more attention has sometimes been paid to marine habitat preservation, and to upstream controls, leaving the "working estuary" as if in a netherworld. The exclusion of estuaries, intentional or otherwide, is understandable only in the sense that jurisdiction over estuarine waters –though more or less fresh and more or less salty, depending upon time, location, freshwater inputs and tide strengths– have traditionally been left to the port ad marine authorities. But there is no more reason for brackish waters to be regarded as part of the seas than there is for them to be embraced as a part of the drainage basin. Indeed, the estuarine zone shares characteristics and problems from both realms. However, the importance of the uses and regulation of a basin's freshwater, including the great increase in polluting uses, should mandate inclusion as part of the basin for planning and regulatory purposes, without by any means ignoring the concerns of the marine side of this critical environment.

Many legal challenges are emerging. Among these will be regimes for: 1) ensuring the delivery of minimal freshwater flows to various segments of the estuarine zone; 2) acquiring title to key lands, such as privately owned marshes; 3) compensation or tax relief for surrender of development rights; 4) zoning for estuarine area preservation; 5) fostering research, including

research in cooperation with other countries; 6) limiting access while permitting high value resource exploitation; and 7) recognition or the setting up of public trusts or other machinery for the control of critical estuarine habitats **203/**. This last aspect has singular importance for those countries considering the establishment of reservations in their interface zones.

CHAPTER IV - **SOME TENTATIVE MANAGEMENT GUIDELINES**

This part of the study must be more of an "agenda" for further deliberation and experimentation than a confident exposition and analysis of tried and true management principles and techniques. The points set forth below are distilled from long study of experience around the world to date with estuarine zones and the diverse, existing literature on management aspects of the topic. All management studies thus far are quite focused on a single facet, such as salmon ranching or wetlands preservation. The state of our understanding is probably not ripe for a comprehensive management study of any validity. Thus, the following propositions are offered as points of departure, or debate.

A. **The integrated approach**

The first need is to achieve integrated oversight, at least, of the interests and processes involved in the totality of the estuary, its basin and its significantly interactive wetlands, shores and marine areas. The traditionally separate administrations must somehow be bridged. This is no easy task **204/**. Only a few years ago did the concept of integrated management of surface waters within the freshwater basin (perceived without a brackish terminus) gain acceptance, and then only in principle. Practice leaves much to be desired. Now the struggle is finally being won for the integration of underground waters, again in principle only **205/**. If the "experts" now persuade the policy makers of the interdependencies with estuarine waters, conceptual integration may be accomplished, but the legal and institutional tasks can be forbidding in some countries. In other countries the personnel and funding requirements may be prohibitive.

To all of this must be added the connections between estuarine waters and the true seas. Both nearby and any far-off linkages must be taken into account. "Where will it end?" The planner and the natural resources lawyer cannot deal with everything at once in this sector - water - even if it is

not as intimidatingly all-embracing as the "environment" **206/**. Hydrologic unity does provide the organizing principle. In practical terms offshore ocean waters and atmospheric water may need to be dealt with separately, but coordination links with the seas regimes will need to be provided. What is the optimum combination of authority and functions need to be pondered in each case. Some useful guidelines could nonetheless be drawn up **207/**.

B. The matter of delimitation

Closely related to the essentially institutional problem set forth above, the legal regime will require some territorial bounds somewhere. If the watershed limits remain serviceable for jurisdictional purposes upstream, to where in the area on both sides of the estuary will the institutional authority most usefully extend? The local **divortium aquarum** on the flats may be indistinct or without meaning.

And where will the estuary-basin organization's authority be cut off seaward? The oft-used baseline from which the territorial waters are measured has no utility in most estuarine situations. The jurisdiction of any extant, all-encompassing coastal zone management institution must be dealt with, as must any authoritative provincial or local government agency jurisdiction, and the powers of any "special district government" such as a port authority, wildlife sanctuary agency, or water supply district, or an extractive operation (e.g. oil and gas) **208/**. The delimitation of authority, in all but the undeveloped coastal areas, presents a serious challenge.

C. The land use issue

At the international level, and to some extent still at national levels, it is a fact that the regime for land use - zoning, construction and dredging permits, and cultivation and herding controls - are entirely independent of the water use regime and agency. Upstream and down, the inability to impose review and licensing structures on activities on land that affect water quality is a major drawback in effective water resources management, above all with respect to the estuarine zone. As is well-known, agricultural activities as well as industrial, municipal, recreational and other uses of land usually have side effects that significantly degrade the

water resources into which pollutants have leached. What is less well appreciated is the tendency of pollutants to concentrate in, and in many cases be retained by, the estuary. Much attention is paid to the rare and ultimately less damaging major oil spill than to the ongoing contamination from uses of the land **209/**.

The need for cooperation between land use planners and managers and water resources planners and managers requires no demonstration to the water experts in the field. The same holds true for land use planning and practices on both sides of the border in a shared basin. But to defend jurisdiction is a universal human trait. Rational management principles often, and at least initially, are to no avail. The awakening of officials and of many individuals, at all levels, to the mounting threat to the very life of our estuaries may provide the opportunity to bring the land use regime and the water resources regime into productive harmony, internally and interjurisdictionally **210/**. Failure to achieve such collaboration has been a long-standing lament of the water resources specialists **211/**. Now that the new regimes for marine pollution have breached the barriers to treating interrelated lands as part of the problem, progress with respect to rivers and lakes may become easier.

D. The role of science

The results of a multitude of scientific studies are obviously motivating policymakers to respond to deteriorating conditions in many estuarine zones around the world. These findings and their dissemination have been invaluable, but scientific "position" cannot set policy for government, which must place many diverse interests into the balance. When policy decisions have been made, the legal regime and institutional structure will be fashioned, or modified, in order to carry out the policies. It is always to be hoped that both law and organizational machinery adequate to fulfill the policy expectations will be drawn up and approved **212/**.

One crucial cornerstone in the building of the legal foundations for natural resources management has in the past been neglected if not ignored. That cornerstone is a real correspondence between the natural facts and

processes and the definitions and concepts employed in the law. There are those who still today can be heard to insist that legal definitions do not have to compare closely to the scientists' definitions, in other words they can use a scientific term and define it as a word of art. It is certainly true historically that drafters of laws have often done so, both intentionally and out of ignorance of true behaviour or conditions, for example in groundwater law. But if the goal is rational management of resources, then one suggested guideline would be for the lawyers and planners and administrators to understand fully what is available and what is happening in nature, and then to design laws and other machinery based on the scientific knowledge but also responsive to the problems presented by human uses of the resources.

Thus, concepts like "estuarine waters" and "drainage basin" should not be delimited by arbitrary legal criteria. Leaving some natural element out of such definitions will in the long run prove troublesome. The subjects of the law will be confused; the objects of the law will be misread; and the administrators, in the end, misled. Science is not usurping lawyers' prerogatives when legal propositions about natural phenomena build upon the terminology and categorizations of the scientific community.

Finally, the ecologists and other scientists must provide to planners and legislators an understanding of the consequences, good and bad, of changes in the estuarine environment in order that all trade-offs will be k-now **213/**.

E. Data dissemination and impact assessment

A perennial management problem is adequate data and other information in order that planning can proceed on a sound basis and projects and programmes be subjected to ongoing monitoring. The law should facilitate the collection and processing of data pertinent to evaluation of processes at the interface, just as it does for other hydrologic and environmental questions. Baseline data should of course also be provided. The guideline here is to urge that data on all waters and water-related phenomena be handled in a uniform manner in accordance with a prescribed scheme. Many times accurate

calculations cannot be made, or conclusions drawn, because of data incompatibility and incompleteness.

Furthermore, information and data should be disseminated on a timely and periodic basis to those who need the data for their work. Where various agencies are involved, or more than one government, a data sharing programme needs to be implemented. There are practical problems in achieving this obviously important tool of management. Simplified designs, restrained requirements and efficient personnel may be among the keys to success.

Only when a sufficient data base is available can the special studies leading to environmental impact assessments (EIA) be carried out properly. The EIA are mostly focussed analyses of data "in the computer", supplemented to be sure with special studies, which themselves will depend mostly on information already gathered or in the process of being gathered. Since the vulnerability of estuaries will call increasingly for environmental assessments, management's attention to the ongoing data programme is critical **214/**.

F. The "water rights" of the estuary

If the "health" of an estuary, or of an entire interface zone, is of importance to the human community it "serves", then it behooves that community to see to the estuary's basic needs. These are essentially water and nutrients, the latter largely carried into the estuary in water **215/**. Water, then, is indispensable. But not just any water. Inorganic and organic materials, such as sediment, in the "customary" amounts and at the "customary" seasons preserves stability, assuming that at the same time the traditionally expected quantities of water are being delivered **216/**.

The quality of the seawater entering from ocean-side is of some importance, too. This contribution is on the whole much less likely to be unstable or dangerously contaminated, except when the estuarine waters themselves have pushed out pollution from the rivers, sewers, etc., offshore and it is not carried away by ocean currents.

In short, a valued estuary must be cared for. And since an adequate supply of freshwater, to mix with the seawater to make the brackish estuarine "soup", is a sine qua non, management should arrange for it on a secure basis **217/**. Many estuaries have been deprived of some of their freshwater regimen, which is why they are "sick" and why people who ingest their products may also be stricken. Many estuarine species have low production or survival rates where the environment is highly saline; the lessening of freshwater reduces the size of the estuarine habitat **218/**. And pollution problems are exacerbated with diminished dilution.

If the above statements are correct, then it would seem appropriate, if not essential, to create a kind of water "right", so that the needed deliveries can be assured. The imposition of minimum flow regimes is not a novel or untried idea **219/**. Various legal aspects of such a so-called right merit further consideration, such as priority, treatment in time of drought, lapse (or forfeiture) and transferability, under certain future circumstances. After all, the water is presumably valuable. There is no reason for an estuary that is so modified or contaminated as to lose its viability to enjoy necessarily a perpetual water right. But while it is viable, it must have water. This guarantee is of unusual importance since the estuary is, so to speak, the last taker, at the end of the "ditch".

Ideally, optimal "salinity, sediment and hydrological regimes should be considered as conservation goals for each estuary. These regimes must consider seasonal, annual and historic variation. If these goals are properly established and implemented they will protect estuarine ecosystem functions and processes" **220/**. The needs of estuaries and deltas for "quality" freshwater and for distinctive flow regimes should by no means prevail over "upstream" interests in many situations. But if the estuarine ecosystem is deemed worthy of preservation, some protective and control provisions will have to be imposed involving sacrifices or concessions after careful evaluation. The water and land management regimes and plans will be, as a result, at least somewhat modified. The estuary will have some "rights" and other uses in the catchment area will have **some** new limitations.

If a defiled estuary is to be abandoned to "fate", on the basis of a political decision, the law should require the development of scientific and economic data sufficient to determine the "price" to be paid, including the long-term future of fisheries, recreation and the amenities **221/**. If an extraordinarily protective regime is to be adopted, similar requirements of investigation and consideration are needed, in order to allow evaluation of the developmental and non-interface-dependent commercial values at stake. In short, the estuarine habitat deserves "due process", as do the other interests, though they may be incompatible, in whole or in part, with preservation **222/**.

G. Which agency prevails

As with all sectors, the problem for rational management of the interface zone is how best to effectuate integrated planning and controls in order to harmonize, as much as possible, the various interests. In most countries, besides, several agencies are already "on the scene" and exercising their respective jurisdictions. In some countries and with respect to some particularly valuable estuarine use or uses, one agency may have been given prevailing authority, with other agency interests treated as ancillary to the lead interest. Even in such clear-cut circumstances a coordinating board or supervisory body may be advisable to institutionalize the inputs from the other sectors and jurisdictions. Where there is no effective coordination, the individual agencies and authorities tend to pursue their often separate objectives, or the strong agency may run roughshod over other interests without due consideration and adjustment.

Because of its oscillating, hybrid nature, the estuary brings into play even more agencies than would be the case for any "normal" body of water. Within the institutional constellation, the freshwater sector, including water quality, must be fully represented. Also the several maritime interests must be present. These, with the participation of others such as urban development and the port authority, must find a suitable way to act upon the nation's or region's interface affairs.

The main point here is that it is not suggested that the estuarine zone should be wrested from the jurisdiction or control of the marine or special coastal agencies, nor that the latter be empowered to replace or subordinate river basin commissions. Such organizational hegemony should, of course, be considered in special cases, but is not likely to be practical or practicable in most situations. Institutional accommodation, while all sides take a more active and broad-minded interest in estuarine welfare, is the guideline. A largely "maritime" outlook is incomplete, but so is the freshwater point of view. Any claim of exclusive competence and expertise may be flatly rejected. A composite approach may be attained by a unified, or composite, agency, or by an authoritative supervisory or coordinating body.

CHAPTER V - **SUMMARY AND CONCLUSIONS**

Even though estuaries have been dubbed "nature's caldrons", human use of the waters and human settlement at these aquatic junctures predates recorded history. Communication to and from the interior, and along the coasts must have comprised the earliest uses of these fruitful, pivotal regions. But the roles played today in relationship to man are numerous; the "bowl at the bottom of the basin" is often saturated with uses.

Identification of the various roles of estuaries, deltas, their related coastal and fresh waters was designed to lay the foundation for consideration of the legal and institutional aspects of estuarine zone management. The need to understand the physical, chemical and biological equations was at least demonstrated. Our utilization of natural resources can be rational and lead to optimum practices only if we comprehend the forces and balances of nature upon which we have been, often blindly, encroaching. Man will use the resources in his environment. His long-term survival may well require him to be "respectful" of nature; the case of the estuarine zones is turning out to be a real test of our abilities to utilize without befouling excessively, to reap benefits without consuming nature's "capital investments".

A. **The ecological roles of deltas, estuaries and coastal zones**

Physical, chemical and biological conditions and events in the areas where waters from the land and water from the sea meet and interact are highly complex and interdependent. As predator and agent of change, man has increasing impact on the conditions and events. Man's own activities are often in turn contingent upon and limited by the processes occurring in these interface areas. These mutual influences extend beyond the delta or estuary to the whole of the drainage system and also, in many cases, along adjacent shores and marine areas. Intensification of use of these estuarine zones is altering the natural processes, often to man's detriment and perhaps to the detriment of the environment as such. Beneficial results from alterations,

natural as well as man made, have also been observed. Even if certain changes are damaging, and the trend is clearly toward increased difficulties and harm, the need to provide food, housing and services to growing coastal populations must be weighed against the losses entailed thereby.

As the point of departure, then, for rational management, some comprehension of the processes involved and of the purposes fulfilled by these zones is essential. Though true, "typical" situations may not exist, the range of examples chosen should have provided a sufficiently broad picture to enable the reader to appreciate the nature and scope of the problems to be confronted in many other situations.

B. The threat and the promise

Marine pollution is largely coastal. "Man's capacity to alter the character of the open oceans or their productivity is quite limited" **223/**. His damage-causing activities are most evident "in shallow coastal waters and particularly in estuaries..., inlets and semi-enclosed seas, e.g., the Baltic... and the Mediterranean ..." **224/**. Therefore, pollution control and prevention efforts need to be calculated to produce results above all in the estuarine zone. Preoccupation with "marine" or "river" pollution tends to result in neglect of the most valuable links in the hydrologic cycle.

The estuarine pollution question is already at the crisis level in many cases. The following conclusive statement from the scientific community is adopted **225/**.

> "The estuarine environment is particularly subject to human pressure. Any estuary deep enough to admit ships inevitably attracts development while those which are shallow with low-lying shores are much in demand for recreational activities. Moreover, the rivers that discharge into estuaries are invariably regarded as natural outlets for sewage and industrial wastes produced inland... Although fish kills in rivers and estuaries as the result of the occasional inadvertent release of poisonous substances, such as cyanides, make the headlines because the damage is clearly evident, the gradual depressing effect of reduced oxygen levels and high suspended matter loads is much more serious... local and regional authorities generally tend to regard their sewage and waste disposal problems as solved if they can reach an estuary or the sea.

...

"Sewage disposal undoubtedly constitutes the main source of marine pollution problems. It is a worldwide problem which is bound to increase in importance in all countries whether developed and industrialized or undeveloped and mainly engaged in primary production...

...

"Significantly damaging effects of pollution are likely to be confined to coastal waters and, particularly, estuaries, especially where soft bottom sediments absorb and retain substantial amounts of potentially harmful metals and persistent organic substances. More attention should be given to the condition of these sediments, to the mechanism by which pollutants accumulate and are released and to the exchange between water, sediments and biota.

...

"Because, locally, habitat modification and disturbance due to development and human pressure may be even more damaging than reduction in water quality due to the discharge of sewage and industrial wastes, it may be desirable to designate certain estuaries, inlets, bays and even stretches of open coast as "areas of special importance to fisheries" because of their high productivity, unique environmental conditions, use as spawning grounds or migration paths, and to give these special protection by means of planning restrictions. The need to protect highly productive agricultural land has already been generally conceded but, as has often been stated, the yield of protein-rich food from well-managed shellfish beds may equal or exceed that from good-quality farm land."

...

In short, our water pollution problems tend to concentrate in the interface zone. Ironically, the successes enjoyed from the reduction of river pollution have not infrequently been at the expense of bays, estuaries and coastal waters, because the cheap "remedy" produced a proliferation of redirected and extended sewer outfalls to the coast and increased indiscriminate dumping of sludge and rubbish off the coast. The currents and tides may transport the pollution onto the marshes and beaches, as well as into deltas and estuaries **226/**. Greater consideration by those "managing" water uses for the "health" of our deltas, estuaries and adjacent coastal waters is overdue.

C. Charge to the legal and administration specialists

It must be apparent that this study is aimed at those water resources specialists, including commissioners and professionals of river basin

organizations, who have not yet realized how often their "sins" are "paid for" in the estuarine zone. And also, at the international lawyers specializing in the law of the sea who rather innocently assumed that estuaries (if they perceived them at all) were merely ancillary arms of the sea. That era is over, to be sure, and some lawyers and political scientists are now devoted to clarifying the legal and institutional problems. Until government agencies, under properly integrative legislation, link, up the marine with the brackish with the fresh, it is likely that conditions in the major deltas and estuaries of the world will continue to deteriorate. Some time ago, in professional circles, drainage basin replaced the older "rivers and lakes" conceptualization. It is now time to acknowledge that, preeminently, the basin concept implies the receptacle at the bottom, into which all else drains. Granting the estuary "full membership" in the list of watercourse components abets interaction with the coastal and marine specialists who tend to view the watershed as simply tributary to "their" estuary. Reciprocal awareness may make accommodation between the two views possible. The resulting reformulation of concepts and redesign of management machinery should benefit the entire system.

Since most water lawyers and most "law of the sea" lawyers have been preoccupied with other important business, the job of responding to the legal issues within particular interface zones has often been left to local authorities and their technical advisers. Consequently integrative doctrine, which would allow an overview in natural resources law and institutions terms, has not developed. Water resources system may need redefining, among numerous conceptual tasks. Applicable rules of water law and of the law of the sea need to be modified enough to make a proper meshing of the two regimes in this in-between region. A harmonized, composite legal regime must emerge.

Where marine area or river basin institutions are absent, powerless or too restricted in their jurisdiction, these inadequacies need to be cured, and collaboration instituted in order to preserve the fragile estuaries from future spoliation or unplanned development. Individual interface zones require specific study, with respect to apt legal and institutional arrangements. But, the individuality of watercourse systems and the

exceptional diversity of the seas notwithstanding, the management of freshwater resources and of the oceans has benefited from, and progressed with, the development of principles and rules of general application. Some of the results are seen today in the law of international watercourses and the law of the sea, both important and useful bodies of principles and rules. So it can be for freshwater-maritime interface zones.

This is not the only field with respect to which water law and administration specialists need to redouble their efforts. It is, however, a neglected dynamic and critical area meriting careful evaluation and alignment with relevant scientific findings. Further neglect would be regrettable. In truth, the record is not entirely bare on the freshwater side of the law with respect to estuarine affairs, but the thinking and the studies and management practices usually do not yet consider carefully the brackish water dimension when working with water resources law and institutions, particularly with regard to systems shared by two or more States.

On the other hand the legal and institutional growth in the marine field shows forthright acceptance of, for example, the relationships between regulation of land use and protection of the aquatic environment. Great resistance is still encountered to tying land use to freshwater resources management, most evident at the non-technical international level. The real and crucial interdependencies are, thus, not yet acknowledged, retarding growth in the law of freshwaters as compared to the law of the sea. If the marine specialists and the freshwater specialists, together, consult with the estuarine zone specialists, in an effort to come to grips with the ever-more pressing estuary-basin problems, perhaps some of the conceptual barriers to effective natural resources management can be overcome.

D. The importance to developing countries

The conditions in the estuarine zones of developing countries vary widely. There are numerous river deltas, and estuaries, where human concentrations or industrial interventions are still minimal. The great river deltas of the Orinoco, the Niger and the Amazon are prominent examples **227/**. On the East coast of Africa, the great Zambezi River debouches in an

undeveloped site on the littoral. In Ghana, a major river delta, that of the Volta, encounters the sea at a point of little development. Also illustrative are the Gulf of Marjaban in Burma (especially the eastern and upper reaches involving the Sitang and Salween Rivers); India's Gulf of Khamhat (the Normada and Mahi Rivers' estuary); the Kaladun River-Lemro River estuary in Burma; and the upper Gulf of Liatsoung, China (served by, among others, the Daginghe, Xinkaihe and Liaohe Rivers).

But there are intensively used estuaries also. And the development aspirations of, and the population increases occurring in, the developing world spell heightened river, port and groundwater contamination in the future. In numerous developing countries, agricultural, industrial, mining and harbour pollution, combined with human wastes, has already rendered certain estuarine waters unfit for drinking and for use as fisheries, including mariculture. The accelerating changes taking place at the interface physical chemical and biological - will defeat many estuarine development efforts or make many schemes alongshore, or in the interior of the estuaries' basins, counterproductive unless the costly lessons taught to most developed, and to some developing, countries can be heeded now. Every effort must be exerted at an early stage so that policymakers, planners and legislators may become apprised of the dynamics of their maritime interface morphology, populations and cycles. This knowledge must be taken into account with respect to any policy or project that will affect not only the estuary proper but its zone of reciprocal influence and, without fail, any activities in the interior involving directly or indirectly the estuaries' drainage basin waters.

It is clear that in the past the impacts, at the basin's bottom, of many projects, have not been adequately considered. For good reason, considerable attention is being given, for example, to coastal and inland water transport in developing countries. Tasks such as river regulation and channelling, dredging and navigational aids are central to infrastructure improvement. Thus, attention needs also to be paid to the specific problems of stability of estuary habitats associated with upriver training works as well as with ports, and navigation in and through estuarine-deltaic zones. Similar caution regarding estuarine consequences is needed also for schemes

for irrigation, pest control, deposit of mine tailings and discharge of domestic waste. Some estuaries have remarkable powers of self-rehabilitation, over time, but the extent and duration of damage for a particular degradation is difficult to ascertain. The future of coastal developing countries involves, with few exceptions, development of the uses of and yields from estuarine waters. Protection of those waters, to ensure continuation of those uses and yields, will require active monitoring and enforcement programmes, grounded in comprehensive drainage basin-estuary-coastal waters legislation. One student of these problems hopes that it will finally be realized that "a sound economy cannot be built on a damaged environment" **228/**.

FOOTNOTES

1/ Development in some countries has not yet seriously threatened nature along the interface; in other countries, including some developing countries, the gathering impacts are not yet fully perceived, or acknowledged. Most of the industrialized countries, almost by definition, have already had to deal with the problems; the illustrations richest in lessons for developing countries have, nonetheless, been taken from a variety of areas with diverse situations and experiences.

2/ On the importance of freshwater flow, see esp. G. Gunther, "The Fertile Fisheries Crescent", **Journal** of the Mississippi Academy of Science, vol.9, pp. 286-290 (1963); N. Benson, "The Freshwater-Inflow-to-Estuaries Issue", **Fisheries**, vol. 6(5), pp. 8-10 (Sept.-Oct.1981)

3/ K.Dyer, **Estuaries: A Physical Introduction**, London: John Wiley, 1973, page v.

4/ M.Stevenson, "Seasonal Variations in the Gulf of Guayaquil, a Tropical Estuary", **Boletin Cientifico y Tecnico** (Instituto Nacional de Pesca, Guayaquil) vol.4(1), pp. 107- 133, at 108-109, 123.

5/ See A. Heydorn, "Coastal Zone Management and Conservation", **Ocean Management,** vol.4, pp. 303-317 (1978). "It is erroneous to consider estuaries as individual entities... they must be seen in the context" of the "overall estuarine environment". **Ibid.,** p. 313.

6/ Bowden, **Estuaries** (1967), quoted in Stevenson, **op.cit.,** p. 110. Ship captains have practical experience with tidal currents, as well as estuarine navigational obstacles such as sandbars, and protect their vessels accordingly. See, **inter alia,** C. Peterson, "The Physical Oceanography of the Gulf of Nicoya, Costa Rica, a Tropical Estuary", **Bulletin** of the Inter-American Tropical Tuna Commission, vol.4(4), pp. 139-216 (1960); E. Forsbergh, "On the climatology, oceanography and fisheries of the Panama Bight", ibid., vol. 14 (2), pp. 49-385 (1969); A. Ippen, **Estuary and Coastline Hydrodynamics,** New York: McGraw-Hill, 1966; W.Cameron and D.Pritchard, "Estuaries" in **The Sea,** New York: John Wiley, 1963.

7/ G. Riley, "The Plankton of Estuaries" in **Estuaries,** G. Lauff, ed., American Association for the Advancement of Science Pub. 83, pp. 316-326 (1967).

8/ See, on long-term mixing, G. Krause, "Physical Processes in Tidal Estuaries in Relation to the Monitoring of Water Quality", **Ocean Management,** vol. 6, pp. 299-314 (1981).

9/ K. Dyer, **Estuaries: A Physical Introduction, London,** John Wiley, 1973, p. vii.

10/ This explanation is a brief composite. On the classification of estuaries by topography (drowned river valley/coastal plain; fjords; bar-built; etc.) and by salinity structure (highly stratified/salt wedge; highly stratified/fjord; partially mixed; vertically homogenous), with examples, see K. Dyer, **Estuaries: A Physical Introduction,** London John Wiley, 1973, pp. 4-42.

11/ **Ibid.,** p.114

12/ **Ibid.**

13/ **Ibid.** See also, D. Pritchard, "Dispersion and Flushing of Pollutants in Estuaries", **Journal of the Hydraulics Division,** American Society of Civil Engineering, vol. 95, pp. 115-124 (1969).

14/ C. Garside, T. Malone, O. Roels and B. Sharfstein, "An Evaluation of Sewage-derived Nutrients and Their Influence on the Hudson Estuary and New York Bight", **Estuarine and Coastal Marine Science,** vol.4, pp. 281-289, at 281. See also, G. Howells, T. Kneipe and M. Eisenbud, "Water Quality in Industrial Areas, **The Oceanography of the New York Bight,** vol. 12, no. 1, Cambridge, MA (U.S.A.): M.I.T. and Woods Hole Oceanographic Institution, 1951; E. Perkins, **The Biology of Estuaries and Coastal Waters** (1974)

15/ See, e.g., J. Lefevre, J.C. Cochard an J.R. Grail, "Physical Characteristics of an Inshore Area on the Atlantic Coast of Brittany and their Influence on the Pelagic Ecosystem: The Case of the "Riviere d'Etel", **Estuarine, Coastal and Shelf Science,** vol. 13, pp. 131-144 (1981).

16/ Interim Mekong Committee, Role of Environmental Factors in Internationally Shared Water Resources, prepared for the United Nations Interregional Meeting of International River Organizations, Dakar, 1981 (MBP.5, Sept. 1980, by V. Pantulu), pp. 32-33.

17/ The Bristol Channel (United Kingdom) is a case of a very turbid estuary combined with a **long** flushing time; the riverine inorganic nutrient input is large. See I. Joint and A. Pomroy, "Primary Production in a Turbid Estuary", **Estuarine, Coastal and Shelf Science,** vol. 13, pp. 303-316 (1981).

18/ Interim Mekong Committee, **op. cit.,** p. 32.

19/ **Ibid.**

20/ **Ibid.,** quoting G. Behara, **et al,** The Composition of Mekong River Silt and its Possible Role as a Source of Plant Nutrient in Delta Soils, Honolulu (USA), University of Hawaii, January 1974.

21/ **Ibid,** quoting Behara, **et al.**

22/ **Ibid.,** pp.30-31.

23/ **Ibid.,** p. 31.

24/ **Ibid.**

25/ See N. Smith and G. Kierspe, "Local Energy Exchanges in a Shallow Coastal Lagoon: Winter Conditions", **Estuarine, Coastal and Shelf Science,** vol. 13, pp. 159 **et. seq.** (1981) and works there cited; S. Hsu, "Micrometeorological Fluxes in Estuaries" in **Estuarine Transport Process,** Columbia, SC (USA), University of South Carolina Press, 1978, pp. 125-134. See generally, J. Harvey, **Atmosphere and Ocean: Our Fluid Environments,** New York: Crane, Russak, 1978.

26/ F. Maclntyre, "Why the Sea is Salt", Scientific **American,** vol. 223 (f), pp. 104-115, at 106, 114-115 (1970). See also, D. Correll and D. Ford, "Comparison of Precipitation and Land Runoff as Sources of Estuarine Nitrogen", **Estuarine, Coastal and Shelf Science,** vol. 15(1), pp. 45-56 (1982).

27/ T. Wu, "Atrazine Residues in Estuarine Water and the Aerial Deposition of Atrazine into Rhode River, Maryland", **Water, Air and Soil Pollution** (Dordrecht), vol. 15 (2), pp. 173- 184 (1981)

28/ This may become true where man intervenes to divert much of the surface water's natural flow in such a way that it does not reach the delta or estuary.

29/ U. Foerstner, "Inorganic Pollutants, Particularly Heavy Metals in Estuaries", in **Chemistry and Biogeochemistry of Estuaries,** E. Olaussan and I. Cato, eds., New York: John Wiley, 1980, op.cit., pp. 323-325.

30/ For further details, see Foerstner, **loc.cit.**

31/ There is new and extensive literature on groundwater depletion and pollution **landward,** but scant investigation has been made of such conditions in the interface zone. See R. Johannes, "The Ecological Significance of the Submarine Discharge of Groundwater", **Marine Ecology Progress Series,** vol. 3, pp. 364-373 (1980), and cases and works there cited.

32/ **Ibid.,** p. 365.

33/ **Ibid.,** p. 365-366.

34/ **Ibid,,** p. 368.

35/ **Ibid.,** p. 370. See also, P. Sewell, "Urban Groundwater as a Possible Nutrient Source for an Estuarine Benthic Algal Bloom", **Estuarine, Coastal and Shelf Science,** vol. 15, pp. 569-576 (1982).

36/ R. Fairbridge, "The Estuary: Its Definition and Geodynamic Cycle", in **Chemistry and Biogeochemistry of Estuaries, op. cit.**

37/ The root is in the latin for tidal, boiling (seething agitation). Other definitions include: "The tidal mouth of a great river, where the tide meets the current" (Oxford Dictionary); "inlets entered both by river and the tides of the sea (Lyell); (a) a passage, as the mouth of the river or lake where the tide meets the river current; ... an arm of the sea at the lower end of a river; a firth, (b) in physical geography, "a drowned river mouth, caused by the sinking of land near the coast" or "a narrow arm of the sea at the mouth of a river, up which the tides penetrate twice daily", (Webster's Dictionary); a semi-enclosed body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage" (Pritchard, 1967). From **ibid.,** p. 4.

38/ **Ibid.,** p. 7, following Dionne, 1963.

39/ **Ibid.**

40/ Where there is a strong "tidal bore", this limit may be over 100 km beyond the saltwater intrusion in some cases.

41/ The Puget Sound (U.S.A.) estuary is itself complex, with several major urban centres. But it in turn forms part of a such more elaborate estuary system involving the Straits of Georgia (Canada) and the Strait of Juan de Fuca (U.S. and Canada).

42/ By progradation, such delta-rivers may form estuaries out of the sediment deposition pattern. R.Fairbridge, **loc cit.,** p.2.

43/ Quoted by Fairbridge, **loc cit.,** p. 12.

44/ The infilling and progradation processes are functions of the river sediment load and flow rate, the interface zone's exposure to storms and the fill that is provided from offshore and alongshore. The prevailing winds and the ocean currents generated thereby, as well as the strength of the tidal action, are also key variables. See Fairbridge, **loc cit.,** p. 32 and **passim.** See also **The Coastline,** R. Barnes, ed., New York: 1977; **The Estuarine Environment,** R. Barnes and M. Green, eds., London: 1972; E. Bird, Coasts, Cambridge, MA (U.S.A.): 1968; J. Dionne, "Towards a more adequate definition of the St. Lawrence Estuary", **Zeitschr. fuer Geomorph.,** vol. 7(1) pp. 36-44 (1963).

45/ See, e.g., E.Adum, "The Role of tidal marshes in Estuarine Processes", **Conservationist,** vol. 15 (6), pp. 12-15 (1961); J. Gosselink, **et al., The Value of the Tidal Marsh,** Baton Rouge, Louisiana, (Louisiana State University Center for Wetlands Resources, 1974; W. Patrick, **et al.,** Nitrate Removal at the Water-soil Interface in Swamps, Marshes and Flooded soils, Annual Progress Report, Environmental Protection Agency (U.S.A.), 1971 (Project 1605 FJR, LSU).

46/ estuarine productivity and water chemistry" in **Marine Science,** vol. 11; **Estuarine and Wetland Processes,** P. Hamilton and K. Macdonald, eds., pp. 437-526 (1980).

47/ J. Teal and M. Teal, **Life and Death of the Salt Marsh,** Boston, 1969.

48/ On the estuarine connections of marshlands, and the situation in the USA, see L. Jerome, "Marsh Restoration, Economic Rewards of a Healthy Salt Marsh", **Oceans,** vol. 12(1), pp. 57-59 (Jan.-Feb. 1979); M. Blumm, "Wetlands Protection and Coastal Planning: Avoiding the Perils of Positive Consistency", **Columbia Journal of Environmental Law,** vol.5, 1978, pp. 69-96.

49/ Of course, dredging within the estuary itself often creates more immediate and probably more far reaching disturbances.

50/ The difficulties involved in making delimitations may be highlighted by pointing out that entire Baltic sea is in fact "estuarine". It is a classical drowned river valley, but of extraordinary extent. The "river", when the level of the ocean was much lower, ran through the narrow passage between Denmark and Sweden, then the Kattegat and Skagerrak to debouch far to the north, into the Norwegian Basin - at that time, the limit of the Norwegian Sea. Its tributaries included all of today's rivers that terminate in the Baltic, including in the Gulfs of Finland, Bothnia and Riga. See **Estuaries and Enclosed Seas,** B. Ketchum, ed., Amsterdam: Elsevier, 1983 (incl. "the Baltic Sea" by G. Kullenberg, pp. 309-336); B. Boczek, "International Protection of the Baltic Sea Environment against Pollution: a Study in Marine Regionalism", **Amer. Journal of International Law,** vol. 72, pp. 782-814 (1978); W. Goralcwyk, "Mer Baltique et les problemes de coopération des etats riverains", **Revue Générale de Droit International Public,** vol. 84, pp. 269-283 (1980); M. Tulokas, "Baltic Sea and Pollution", **Scandinavian Studies in Law,** vol. 25, pp. 205-221 (1981); B. Lundholnr, "The Oceans - Their Production and Pollution with the Baltic as a Case Study" in **Pacem in Maribus,** vol. V (The Ocean Environment) Sanf Barbara, CA (U.S.A.) (Center for the Study of Democratic Institutions); International Council for the Exploration of the **Sea, Report** of the Working Group on Pollution of the Baltic Sea, Feb. 1970 (Cooperative Research Report No. 15, Ser. A.); S. Fonselius, "Nutrient Relations in Baltic Surface Water" in **River Inputs to Ocean Systems** (UNEP/UNESCO, 1980) pp. 319-328. In contrast most of Bangladesh is one giant delta complex.

51/ W.M. Queen, "Human Use of Salt Marshes" in **Wet Coastal Ecosystems,** V. Chapman, ed., Amsterdam: Elsevier, 1977, p. 364; G. Rounsefell, "Realism in the Management of Estuaries" in **Marine Resources Bull. No. 1** (Alabama Marine Resource Lab.), 1963.

52/ These transient species are also called, generally, "diadromous"; those that spawn upstream and mature at sea are, specifically, "catadromous". This field has an enormous literature on the extensive experience with and research on these species. For familiarization, see, e.g., R. Haedrich, "Estuarine Fishes" in **Estuaries and Enclosed Seas,** B. Ketchum, ed., Amsterdam: Elsevier, 1983, pp. 183-203, and works there cited.

53/ "Fishfarming", too, has an expanding technical and scientific literature. See, **inter alia, Advances in Aquaculture,** documents presented to the FAO World Technical Conference on Aquaculture, Kyoto, Japan, 1976, T. Billay and W.M. Dill eds., Fishing News Books Ltd., Farnham (U.K.), 1979; P. Korringa, **Farming Marine Fishes and Shrimps,** Amsterdam: Elsevier, 1976; C. Hickling, **The Farming of Fish,** New York: Pergamon Press, 1968; H. Webber, "Mariculture", **Bio- Science,** vol. 18(10), 1968 pp. 940-945; V. Zaitsev, "Soviet Sea Farm Synopsis", **Oceans,** vol. 12 (2), Mar. - Apr. 1979, p. 20; FAO, Fishery Country Profile, **Malaysia,** FID/CP/MYA Rev. 2, Nov. 1979; J. Madamba, "Subsistence aquaculture and technology transfer among developed and developing countries" in **Proceedings** of the Tenth Annual Meeting of the World Mariculture Society (Honolulu, 1979), Baton Rouge, LA (U.S.A.): World Mariculture Society, 1979, pp. 182-193. J. DeWitt, the Pond, Lagoon, Bay? Estuary, and Impoundment Culture of Anadromous and Marine Fishes, 1969, 36 p. (mimeo).

54/ See, e.g., W. Lindall and C. Saloman, "Alteration and Destruction of Estuaries Affecting Fishery Resources of the Gulf of Mexico", **Marine Fisheries Review,** vol. 39(9), pp. 1-7(1977); A. Ben-Tuvia, "Man-made changes in the eastern Mediterranean and their effects on the fishery resources", **Marine Biology,** vol. 19, 1973, pp. 197-203.

55/ J. Festa and D. Hansen, "A Two-dimensional Numerical Model of Estuarine Circulation", **Estuarine and Coastal Marine Science,** vol. 4? 1976, p. 310. An example of this kind of "misadventure" was in the diversion of water into the Cooper River (South Carolina, U.S.A.) from the Santee River, which promptly gave rise to severe shoaling in the Charleston harbour. **Ibid.**

56/ K. Dyerf **Estuaries: A Physical Introduction,** London; John Wiley, 1973, page v.

57/ E. Bird and 0. Ongkosongo, **Environmental Changes on the Coasts of Indonesia, U.N. University** (NRTS-12/UNUP-197)

58/ See A. Carr, "Tropical Forest Conservation and Estuarine Ecology", **Biological Conservation,** vol. 23(4), 1982, pp,.247-259 (re the Tortuguero, Costa Rica estuary).

59/ M. Sridhar, " A field study of estuarine pollution in Madras, India", **Marine Pollution Bulletin,** vol. 13(7), 1982, pp. 233-236.

60/ Obviously both estuarine flora and fauna may be harmed by contaminants released into the water column by these operations. See, including for a discussion of mitigation measures, S. Johnson, Jr., "Estuarine Dredge and Fill Activities: A Review of Impacts," **Environmental Management,** vol. 5(5), 1981, pp. 427-444.

61/ See P.De Falco, Fr., "The Estuary-Septic Tank of the Megalopolis" in **Estuaries**, G. Lauff, ed., Washington, D.C.: American Association for the Advancement of Science, 1967 (Pub. No. 83), pp. 701-710.

62/ Even **small** estuaries in **developing** countries have increasingly pronounced contamination, usually raw or partially treated sewage. Suspended particles can persist into the ocean. See, D. Turnbull and J. Lewis, **Pollution Ecology of a Small Tropical Estuary in Barbados, West Indies,** Montreal: McGill University Marine Science Centre (No. 35), 1981.

63/ "Estuarine disposal of wastes can be particularly harmful because as much as two-thirds of the marine animal population depends directly or indirectly on estuarine waters". (**Marine Pollution Problems and Remedies,** by 0. Schachter and D. Serwer, UNITAR Research Report No. 4, 1970, p. 13, citing to First Annual Report of the Council on Environmental Quality (U.S.A.), p. 175. For a detailed report on estuarine pollution see U.S. Dept. of Interior, **National Estuarine Pollution Study,** 1969.

64/ There are several important cases of marked salinity **increase** by pollution originating in States **upstream** in the basin. See J. Lammers, "New International Legal Developments Concerning the Pollution of the Rhine", **Netherlands International Law Review,** 1980, pp. 171-193.

65/ Previous discussion of many of the facets of the freshwater-maritime interface has already surfaced a number of the pollution problems. Pollution is of such importance, however, that this separate section seems justified. On the other hand, no attempt can be made to be exhaustive of the many considerations or of the vast literature. The intention is merely to draw the reader's attention to these problems as they affect estuarine processes.

66/ The broad topic of oil pollution of the oceans is beyond the scope of this study, but see for a summary and discussion of unresolved problems, I. Ostrovskii, "International Legal Protection of the Seas from Pollution", **Ocean Development and International Law Journal,** vol. 3(3), 1976, p. 287 **et seq.,** translated from the Russian and reprinted from Ocean, **Technology and the Law,** M. Lazarer and L. Speranskaia eds. (Moscow: Iudisdicheskiaa Literatura, 1972); Eurocean, **Petroleum and the Marine Environment,** New York: Crane, Russak, 1981; L. Juda, "The Intergovernmental Maritime Consultative Organization and the Regulation of Pollution from Ships", **International and Comparative Law Quarterly,** vol. 26, 1977, pp. 558-584; D. Cycon, "Calming Troubled Waters: The Developing International Regime to Control Operational Pollution" **Journal of Maritime Law and Commerce,** vol. 13(1), 1980, p. 35 **et seq.** The basic, 1954 International Convention for the Prevention of Pollution of the Sea by Oil is at **United Nations Treaty Series (UNTS),** vol. 327, p. 3; the 1962 Amendments thereto, **UNTS**, vol. 600, p. 322.

67/ On the interrelationships between agriculture and the interface zone, see L. Rea, "Agricultural Land Preservation: The Case of Carlsbad, California", **Coastal Zone Management Journal,** vol. 10(**1**/2), 1982, p. 141 **et seq.**

68/ U. Fürstner, "Inorganic Pollutants, Particularly Heavy Metals in Estuaries" in **Chemistry and Biogeochemistry of Estuaries, op.cit., p.** 335.

69/ WHO, **Water Pollution Control,** Geneva, 1966 (Technical Report Series, No. 318), pp. 11-12, The present hygienic and aesthetic unacceptability of many such waters for bathing has led to the introduction of numerous freshwater (and saltwater) swimming pools along coasts used for recreation. Adequate filtration and water quality treatment facilities must be installed or expanded. On the crucial significance of the quality of the coastal waters of the Mediterranean, the world's most important tourist region with some 100 million tourists annually and bounded by 18 states, see L. Juda, "The Regional Effort to Control Pollution in the Mediterranean Sea", **Ocean Management,** vol. 5, 1979, pp. 125-150. The principal sources of Mediterranean pollution are land-based, directly from the coast (dumping, outfalls and runoff) and via rivers and canals. Pollution carried into the sea by the Nile, draining 10£ of the African continent, is derived from 8 States before reaching Egypt, raising an important issue of responsibility involving more than the State littoral to the sea. Pollution originating in Switzerland and entering the Mediterranean via the Rhone is another illustration. **Ibid.,** pp. 137-138. See also, B. Boxer, "Mediterranean Pollution: Problem and Response", **Ocean Development and International Law Journal,** vol. 10(**3**/4), 1982, pp. 315-356 and works and activities there cited.

70/ Furthermore, the practice of injecting brines and other contaminants into the ground, or allowing their percolation into the ground, has become common and not only in industrial or mining areas.

71/ New technology has had to be developed for these installations. See S. Diamond, "Curbing Leaky Storage Tanks", **New York Times,** 20 September 1984, D2. Additional hydrocarbon impacts on the interface include pipeline dredging and leakage, drilling residue discharges, pollution activities of surface and water transport and land support facilities, well spillage, and disposal into wells. W. Peters, **Onshore Economic Impact Analysis of Proposed OCS** (Outer Continental Shelf), Sale No. 53, Washington, D.C.: Bureau of Land Management (POCS Reference Paper No. 53(3) 1980). See D. Connell, " An Approximate Petroleum Hydrocarbon Budget for the Hudson-Raritan Estuary - New York", **Marine Pollution Bulletin** vol. 13(3), 1982, pp. 89-93. (Hydrocarbons originate principally from sewage and urban and rural runoff; only moderate percentages may be removed through the mouth of the estuary). See also L. Thibodeaux, L. Chang and D. Lewis, "Dissolution Rates of Organic Contaminants Located at the Sediment Interface of Rivers, Streams and Tidal Zones" in **Contaminants and Sediments,** vol. 1, R. Bader, ed. (Ann Arbor, MI (USA): Ann Arbor Science Pub., 1980, pp. 349-371.

72/ I. Cato, I. Olsson and R. Rosenberg, "Recovery and Decontamination of Estuaries" in **Chemistry and Biogeochemistry of Estuaries, op. cit.,** p. 403, at 404. With respect to sediment decontamination, several factors have been identified which tend to decrease, dilute or imbed the contaminants. In general it is a slow process in estuaries, accelerated if burrowing benthic organisms remain or return. Polluted bottom strata may recover in any case as fresh, uncontaminated materials embed the polluted deposits. **Ibid.**

73/ This vast topic will not be explored here, except as it relates to estuaries and their drainage basins. But see generally, **inter alia. Environmental Protection, the International Dimension,** D. Kay and H. Jacobson, eds., Totowa, NJ (USA): Allanheld, Owmun, 1983, and works there cited; UNEP, **Register of international treaties and other agreements in the field of the environment,** Nairobi: May 1984. UNEP's Regional Seas Programme is ample evidence of the awareness on the part of coastal States that much of the marine environment is in jeopardy. See the UNEP series, Regional Seas Reports and Studies.

74/ E. Manner, "The rights and obligations of States concerning pollution of inland waters and enclosed seas", ECE, Conference on Water Pollution Problems in Europe, doc. WATER POLL/CONF.12, 29 Dec. 1960, vol.11, Documents Submitted to the Conference, pp. 468-472. The high vulnerability of enclosed seas was also stressed: "... Insufficient account was taken (in the 1958 Law of the Sea Conventions) of the special conditions prevailing in the enclosed seas... This deficiency is particularly regrettable in so far as the Baltic Sea is concerned... In its hydrographical features, the Baltic Sea resembles the estuary of a big river. Because of this and other factors, e.g. its relatively small quantity of water, low salinity, numerous islands, lack of tides and its freezing in the winter, the Baltic Sea is more vulnerable to contamination... than are the coastal waters of an ocean... In the progressive development of international law of the sea it would be advisable to pay due attention to the special circumstances of enclosed seas... In one sense an enclosed sea constitutes an integrated area similar to a drainage basin..." **Ibid.** The 1958 Geneva Law of the Sea Conventions, looking to maritime jurisdiction only, do not contain provisions dealing with the interface zone.

75/ Text in Third United Nations Conference on the Law of the Sea, doc. A/CONF.62/122, 7 October 1982 and corrs. 3 and 8 (1982) (hereinafter, "1982 UNLOS Convention", or simply as "the Convention". The Convention is comprehensive and, once in force, would replace the 1958 Conventions for those ratifying it. However, it requires 60 ratifications (plus 12 months) to bring it into force (Art. 308, para.l). Although major portions of the Convention's text may be regarded as declaratory of existing customary international law, the same cannot be said, at least unqualifiedly, for the innovative portions. The articles here pertinent, chiefly from Part XII, Protection and Preservation of the Marine Environment, will for the purpose of this brief exposition be treated simply as 1982 UNLOS Convention provisions without examination of their present or future legal validity.

76/ 1982 UNLOS Convention, Art. 1, para. 1 (4). Emphasis added. Incidentally, "seas" or "ocean" is nowhere defined in the convention.

77/ Art. 2, para. 1. Moreover, though "sovereignty over the territorial sea is exercised subject to this Convention and to other rules of international law" (Art. 2, para.3), no such assertion is made with respect to internal waters. See the Convention's Art. 8 on internal waters: "Except as provided in Part IV (Archipelagic States) waters on the landward side of the baseline of the territorial sea form part of the internal waters of the State" (para.l). See also, Art. 6 (Reefs),

Art. 9 (Mouths of rivers), Art. 10 (Bays) and Art. 11 (ports), as well as Art. 7 on straight baselines generally. See "Baselines" in M. Whiteman, **Digest of International Law,** vol. 4, Washington, D.C., 1965, pp. 137-194, especially pp. 186-192 on internal waters, and documents and works there cited.

78/ Art. 66, para. 1.

79/ Art. 66, paras. 2-5. Arrangements for implementation are to be made by the States concerned through regional organizations, where appropriate.

80/ Ibid., Art. 67. Harvesting, unlike the less strict provision on anadromous fish, shall be conducted **only** in waters landward of the exclusive economic zone's outer limits.

81/ Art. 64. Marine mammals, some of whom use estuaries and some of whom are highly migratory are treated in Art. 65. These living resources articles are part of the Convention's Part V ("Exclusive Economic Zone").

82/ Art. 192; see also Art. 193.

83/ Art. 194, para. 1. Emphasis added.

84/ Art. 194, para. 2.

85/ Art. 194, para. 3(a)

86/ Art. 194, para. 5. Emphasis added.

87/ Art. 195.

88/ Art. 196, para. 1.

89/ Art. 197.

90/ Art. 198

91/ Art. 199.

92/ Art. 200.

93/ Art. 201.

94/ Art. 204, para. 1.

95/ Art. 204, para. 2.

96/ Art. 206, read together with Art. 205. Emphasis added.

97/ Art. 207. Emphasis added. Technically, if estuaries are considered part of the **sea,** then pollution originating therein would not be "land-based". However, Article 208's requirements on pollution from **sea-bed** activities subject to national jurisdiction may be construed as looking seaward from the baseline.

98/ Art. 212. Emphasis added.

99/ Arts. 213 and 214 respectively.

100/ Art. 211, para. 1.

101/ Art. 211, para. 2.

102 Art. 211, read together with para. 7.

103/ Arts. 210 and 216. Several other articles could be examined in this manner, searching for any clear perception of components of the interface zone as part of the environment to be protected. See, e.g., Art. 234 (Ice-covered areas), concerned with "major harm to or irreversible disturbance of the ecological balance".

104/ Section 9 of Part XII, Art. 235, para. 1.

105/ Art. 235, para. 2.

106/ These Conventions are, in chronological order:

1. Convention for the Protection of the Mediterranean Sea against Pollution, done at Barcelona, 17 May 1976, text in International Environmental Law (Schmidt Verlag publisher), 976:13. Algeria, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Morocco, Spain, Syria, Tunisia, Turkey, Yugoslavia, and the European Economic Community are signatories to it. The Convention entered into force on 12 February 1978.

2. Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, done at Kuwait, 24 April 1978, text in International Environmental Law 978:31. Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates are signatories to it. The Convention entered into force on 1 July 1979.

3. Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, done at Abidjan, 23 March 1981, text in International Environmental Law, 981:23. Benin, Cameroun, Congo, Gabon, Gambia, Ghana, Guinea, Ivory Coast, Liberia, Mauritania, Nigeria, Senegal, and Togo are signatories to it. The Convention entered into force on 5 August 1984.

4. Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific, done at Lima, 20 November 1981, text in International Environmental Law, 981:84. Chile, Colombia, Ecuador, Panama, and Peru are signatories to it. The Convention entered into force on 19 May 1985.

5. Regional Convention for the Conservation of the Red Sea and of the Gulf of Aden Environment, done at Jeddah, 14 February 1982, text in International Environmental Law, 982:13. Democratic Yemen, Jordan, Saudi Arabia, Somalia, Sudan and the Yemen Arab Republic are signatories to it. The Convention entered into force on 20 August 1985.

6. Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, done at Cartagena (Colombia), 24 March 1983, text in International Environmental Law, 983:23. Antigua & Barbuda, Barbados, Colombia, France, Grenada, Guatemala, Honduras, Jamaica, Mexico, the Netherlands, Nicaragua, Panama, St. Lucia, Trinidad fie Tobago, the United Kingdom, the United States of America, Venezuela, and the European Economic Community are signatories to it. The Convention entered into force on 11 October 1986.

7. Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, done at Nairobi, 21 June 1985, text in **International Environmental Law, op. cit.,** p. 985:46. The signatory States are France, Madagascar, Seychelles, Somalia, and the European Economic Community. As of May, 1989, the Convention had not yet entered into force.

8. Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, done at Noumea, 24 November 1986, text in **International Environmental Law, op. cit.,** p. 986:87. The signatory States are Australia, Cook Islands, France, the Marshall Islands, Micronesia, Naura, New Zealand, Palau, Papua New Guinea, Tuvalu, the United Kingdom, the United States of America, and Western Samoa. As of May, 1989, the Convention had not yet come into force.

107/ Done at Paris, 4 June 1974, text in International Environmental Law, 974:43. Belgium, Denmark, France, the Federal Republic of Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the European Economic community are signatories to it. The Convention entered into force on 6 May 1978.

108/ Done at Helsinki, 22 March 1974, text in International Environmental Law, 974:23. Denmark, Finland, the German Democratic Republic, the Federal Republic of Germany, Poland, Sweden, and the USSR are signatories to it. The Convention entered into force on 3 May 1980.

109/ Done at Athens, 17 May 1980, text in International Environmental Law, 980:37. All signatories to the Barcelona Convention are signatories to the Athens Protocol, with the exception of Syria and Yugoslavia. The Protocol entered into force on 17 June 1983.

110/ Protocol for the Protection of South-East Pacific against Pollution from Land-Based Sources, done at Quito, 22 July 1983, in International Environmental Law, 983:54. The signatories to the Lima Convention are also the signatories to the Quito Protocol. The Protocol entered into force on 23 September 1986.

111/ Done at Ramsar, Iran, 2 February 1971, text in International Environmental Law, **op. cit.,** 971:09. Algeria, Australia, Austria, Belgium, Bulgaria, Canada, Chile, Egypt, Denmark, Finland, France, Gabon, German Democratic Republic, Federal Republic of Germany, Ghana, Greece, Hungary, Iceland, India, Iran, Ireland, Italy, Japan, Jordan, Mali, Mauritania, Mexico, Morocco, Nepal, Netherlands, New Zealand, Niger, Norway, Pakistan, Poland, Portugal, Senegal, South Africa, Spain, Suriname, Sweden, Switzerland, Tunisia, Uganda, USSR, United

Kingdom, United States of America, Uruguay, and Yugoslavia are Parties to the Convention. This entered into force on 21 December 1975.

112/ Council Directive of 4 May 1976, in **Official Journal of the European Communities** (OJ), No. L129, p. 23 (1976).

113/ Council Directive of 22 March 1982, OJ No. L81, p. 29 (1981); Council Directive of 8 March 1984, OJ No. L74, p. 49 (1984); Council Directive of 26 September 1983, OJ No. L291, p. 1(1983).

114/ Council Directive of 30 October 1979, in OJ No. L 281 of 10 November 1979, p. 47.

115/ The Guidelines were drafted in response to UNEP Governing Council decision 10/24 of 31 May 1982, by an **Ad Hoc** Working Group of Experts on the Protection of the Marine Environment against Pollution from Land-Based sources which met between 1983 and 1985 and adopted them in Montreal, Canada, on 19 April 1985. In the light of the Working Group's report (UNEP/WG.120/3), the Governing Council by decision 13/18 (II) of 24 May 1985 encouraged "States and international organizations to take the Montreal Guidelines for the Protection of the Marine Environment against Pollution from Land-based Sources into account in the process of developing bilateral, regional and, as appropriate, global agreements in this field".

116/ "Marine environment" means the maritime area extending, in the case of watercourses, up to the freshwater limit and including inter-tidal zones and salt-water marshes (article 1 letter (c)).

117/ "Freshwater limit" means the place in watercourses where, at low tide and in a period of low freshwater flow, there is an appreciable increase in salinity due to the presence of sea water (article 1, letter (d)).

118/ But see S. Burchi, "International Legal Aspects of Pollution of the Sea from Rivers," **Italian Yearbook of International Law,** vol. 3, 1978, pp. 115-142; E. Manner, "Water Pollution in International Law" in **Aspects of Water Pollution Control,** Geneva: World Health Organization, at p. 70; R. Hayton, "Progress in Co-operative Arrangements" in **Experiences in the Development and Management of International River and Lake Basins,** New York: 1983, U.N. pub. Sales No. E.82.II.17, pp. 65-81; R. Hayton, "Co-operation in the Development of Shared Water Resources," **Natural Resources Forum,** vol. 6, 1982, pp. 167-181.

119/ See, e.g., V. Arnaud, **Derecho internacional ambiental, la contaminación de los rios en el derecho internacional público,** Buenos Aires; Instituto Nacional de Ciencia y Tecnica Hidricas (pub. No. 11), 1974; L. Caldwell, "Concepts in Development of International Environmental Policies" in **International Environmental Law,** L. Teclaff and A. Utton, eds., New York, 1974; Inter-American Bar Association, "Resolution 30" in **Resolutions, Recommendations and Declarations Approved by the XXII Conference,** 14-20 March 1981, Quito, p. 7 (Committee XV, National Resources and Environmental Protection); **Management of International Water Resources: Institutional and Legal Aspects,** New York: 1975, U.N. pub. Sales No. E.75.II.A,2 (by R. Hayton).

120/ Fourth Report on the Law of the Non-navigational Uses of International Watercourses, by S. McCaffrey, Special Rapporteur, UN Document A/CN.4/412 (1988), p. 2. The four Special Rapporteurs who worked on the topic were, in addition to Mr. McCaffrey, Mr. R.D. Kearney, Mr. S. Schwebel (1979-1981), and Mr. J. Evensen (1983-1984). Ambassador Kearney filed an introductory report to the further study of the topic. Mr. Schwebel prepared three reports on the law of the non-navigational uses of international watercourses, while Mr. Evensen authored two such reports. Mr. McCaffrey has been Special Rapporteur since 1985.

121/ Fifth Report on the Law of the Non-navigational Uses of International Watercourses, by S. McCaffrey, Special Rapporteur, UN Document A/CN.4/421 (1989). The actual text of the draft articles adopted in 1987 is in the Preliminary Report on the Law of the Non-navigational uses of International Watercourses by S. McCaffrey, Special Rapporteur, UN Document A/CN.4/393 (1985). The present Special Rapporteur noted in his Fifth Report that he intended to have submitted the full set of draft articles by 1990, and that adhering to this schedule would allow the Commission to complete the first reading of the draft artcles by the end of its current term of office (1991) (page 3).

122/ **Yearbook of the International Law Commission 1980,** Vol. II (Part two), p. 108.

123/ UN Document A/CN.4/412, Addendum 2, p.2 (1988).

124/ Ibid., p. 22.

125/ Fifth Report on the Law of the Non-navigational Uses of International Watercourses, by S. Me Caffrey, Special Rapporteur, UN Document A/CN.4/421 (1989).

126/ **Official Records of the General Assembly, Twenty-Fifth Session, Annexes,** Agenda item 91, doc. A/7991.

127/ Estuarine waters have been found to be fecally polluted well beyond safe limits for shellfish growing. See C. Erkenbrecher, "Sediment Bacterial Indicators in an Urban Shellfishing Subestuary of the Loser Chesapeake Bay", **Applied and Environmental Microbiology,** vol. 42(3), pp. 484-492 (1981); A. Huq, **et al.,** "Ecological Relationships between Vibrio Cholerae and Planktonic Crustacean Copepods", **Applied and Environmental Microbiology,** vol. 43(1), pp. 275-283 (1983); R. Labelle and C. Gerba, "Influence of Estuarine Sediment on Virus Survival under Field Conditions", **ibid.,** vol. 39(4), pp. 749-755 (1980); S. Gittelson, "Bacteria in the Hackensack River Estuary" **Underwater nature,** vol. 11(1), pp. 16-18 (1978).

128/ From Draft Principle 1.

129/ Resolution 3281 (XXIX) of 12 December 1974, Art. 3. See also Art. 30, **ibid.**

130/ For a conceptualization and discussion of this process, see R. Hayton, "The formation of the Customary Rules of International Drainage Basin Law" in **The Law of International Drainage Basins,** A. Garretson, R. Hayton and C. Olmstead, eds., Dobbs Ferry, N.Y.: Oceana, 1967, pp. 834-895.

131/ Convention on the Protection of the Rhine Against Chemical Pollution, Bonn,3 December 1976, text in International Legal Materials (I.L.M.), Vol. 16, p. 242 (hereinafter referred to as the Chemical Pollution Convention). The convention entered into force on 1 February 1979; Convention on the Protection of the Rhine Against Pollution by Chlorides, Bonn, 3 December 1976, text in I.L.M., Vol. 16, p. 265 (hereinafter referred to as the Chloride Pollution Convention). This convention entered into force on 5 July 1985. France, the Federal Republic of Germany, Luxembourg, Netherlands, and Switzerland are all parties to both conventions. The European Economic Community is a party to the Chemical Pollution Convention only.

132/ Chemical Pollution Convention, Article 1.

133/ **Ibid.,** Articles 2, 8 and 10.

134/ Chloride Pollution Convention, Articles 3, 7 and 12.

135/ The agreement of all Parties concerned is recorded in the Declaration of the Heads of Delegation of the Governments Parties to the Agreement Concerning the International Commission for the Protection of the Rhine Against Pollution, Bruxelles, 11 December 1986 (published in the **Journal Officiel de la République Française** of 3 March 1987, p. 2370).

136/ Treaty of the La Plata River and its Maritime Limits, done at Montevideo, 19 November 1973, text in I.L.M., vol.13, p.251.

137/ River Plate Basin Treaty, Brasilia, 23 April 1969, text in United Nations Treaty Series (UNTS) vol. 875 No. 12550. The treaty came into force on 14 August 1971.

138/ Done at La Paz, 14 August 1983, text in I.L.M., vol. 22, p. 1025.

139/ Done at San Diego, 13 July 1985, text in I.L.M., vol. 26, p. 19.

140/ The most comprehensive and up-to-date compilation and analysis, exhaustively documented, is ILC, Third Report on the law of the non-navigational uses of international watercourses, **op. cit.** See also, **The Law of International Drainage Basins, op. cit.;** FAO, **The Law of International Water Resources,** Rome: 1980 (Legislative Study No. 23); **Experiences in the Development and Management of International River and Lake Basins, op. cit.** For the voluminous treaty record, see **FAO, Systematic Index of International Water Resources Treaties, Declarations, Acts and Cases by Basin,** vol. I, Rome: 1978 (Legislative Study No. 15), and vol. II, Rome: 1984 (Legislative Study No. 34). For an overview of the present state of the general rules, see R. Hayton, "Law of International Water Resources System", in **River Basin Development,** Dublin: Tycooly, 1983, pp. 195-239.

141/ Art. II. Text in, e.g., FAO, **The Law of International Water Resources, op.** cit., p. 293 **et seq.**

142/ Ibid. Emphasis added.

143/ K. Cuperus, Rapporteur. Text in, e.g., FAO, **The Law of International Water Resources, op. cit.,** p. 303 **et seq.**

144/ Art. I, 2nd. para.

145/ Art. Ill (a). The weight to be given each factor is to be determined by "its importance in comparison with that of other relevant factors". Art. Ill (c), **ibid.** These rules were intended to supplement the Helsinki Rules. The Association's 1980 rules on Regulation of the Flow on International Watercourses, though "regulation" is defined to include "for any purpose", make no reference to estuarine needs. Text in ibid., p. 312 **et seq.**

146/ Art. 1, Relationship between Water, Other Natural Resources and the Environment. **Ibid.,** p. 314. At the time, the Association recommended that the Committee study tidal energy, which it has not taken up.

147/ But see, **inter alia,** Institute of International Law, Resolution on the pollution of rivers and lakes and international law (Athens Session, 1979), text in FAO, **The Law of International Water Resources, op. cit.,** p. 282 **et seq.;** Inter-American Bar Association, Declaration of Buenos Aires (1957) text in **ibid.,** p. 317 et **seq.;** Resolution on measures concerning accidental pollution of the seas, **Annuaire de l'Institut de Droit international, Edinburgh Session,** vol. 53, Part II, pp. 380-385.

148/ In **Annuaire de l'Institut de Droit international, Athens Session** (1979), vol. 58, Part II, p. 107.

149/ Text in J.F. Garner, **Control of Pollution Act,** 1974, Butterworths, 1975.

150/ Control of Pollution Act, Sections 31, 32. In these provisions, certain expressions are used which are of specific relevance to the estuarial zones. Such expressions are "relevant waters", which include any river, watercourse of inland water, and the sea within three nautical miles from any point on the coast measured from low-water mark of ordinary spring tides, such other parts of the territorial sea adjacent to Great Britain as are prescribed, and any other tidal water in Great Britain; "stream" which includes any river, watercourse or inland waters, and "restricted waters", which means the sea within the three nautical miles in areas designated as tidal rivers and other areas in whch vessels commonly lie at moorings in close proximity to one another (Section 56). As a result, estuaries are within the scope of the Act, and are protected by any provisions pertaining to relevant waters or to streams.

151/ See T. Burton and D. Freestone, **The Control of Pollution Act 1974 and Tidal Waters: Problems of the Implementation of Part II,** International Journal of Estuarine and Coastal Law, Vol. 1, No. 3 p. 241 (1986). The water administration in England and Wales will undergo considerable change as a result of the Water Act, 1989, which has privatized the water industry. As a result, the ten Regional Water Authorities will be reconstituted as Limited Public Companies, and will function as water suppliers and providers of sewage disposal services. Regulatory functions will vest in a National Rivers Authority.

152/ Control of Pollution (Exemption of Certain Discharges from Control) Order 1983, S.I. 1983 No. 1182.

153/ Control of Pollution (Exemption of Certain Discharges from Control) (Variation) Order 1986, S.I. 1986 No. 1623.

154/ Federal Water Pollution Control Act Amendments of 1972, P. L. No. 92-500, 86 Stat. 816; Water Quality Act of 1965, P. L. No. 89-234, 79 Stat. 903.

155/ Federal Water Pollution Control Act Amendments of 1972, section 104 (n)(1),(3).

156/ **Ibid.,** section 104 (n)(4).

157/ **Ibid.,** section 301, 306, 307, 402, 404, 502 (7). See Pedersen, "Turning the Tide on Water Quality," **Ecology Law Quarterly** Vol.15:69 (1988), p. 77. The United States Army Corps of Engineers, whichr administers the Section 404 permit program, estimates that the loss of wetlands has been retarded by 300,000 acres annually. U.S. Army Corps of Engineers, Draft Impact Analysis of the Corps Regulatory Program 112 (1982).

158/ Water Quality Act of 1987, P.L. No. 100-4, 101 Stat. 7, Section 317. Under Section 210, funding was made available "to address water quality problems of marine bays and estuaries subject to lower levels of water quality due to the impacts of discharges from combined storm water and sanitary sewer overflows...".

159/ P.L. No. 99-645, 100 Stat. 3582.

160/ **Ibid.,** section 3(5).

161/ Marine Pollution Prevention Act, No. 59 of 1981, Article 37, Gazette of the Democratic Socialist Republic of Sri Lanka, 18 September 1981, Part II, Supp.

162/ **Ibid.,** Article 6.

163/ Codigo Nacional de los Recursos Naturales Renovables y de la Proteccion al Medio Ambiente. Decree No. 2811 of 18 December 1974.

164/ **Ibid.,** Articles 3 and 83.

165/ **Ibid.,** Articles 132-145.

166/ Ley Organica del Ambiente, 15 June 1976, **Gaceta Oficial de la República de Venezuela,** No. 31.004, 16 June 1976, p. 233.364.

167/ **Ibid.,** Article 2.

168/ **Ibid.,** Article 3.

169/ S. Gittins and A. Akonda, What Survives in Bangladesh? **Oryx**, 16(3), February 1982. Japan has also adopted an ambitious and unique nature conservation policy. The national marine parks total 160, more than any other country. The designated areas are often managed to provide enhanced tourism and productivity on a commercial scale. Such is the case of Izu Oceanic Park, an enclave within that large preserve that embraces most of the Izu Peninsula, a seaside resort (Hakane), seven islands and Mount Fuji. The marine parks are jointly managed by the national park service and local cooperatives of commercial fishermen. A principal aim is to sustain food fish productivity. See E.Clark "Japan's Izu Oceanic Park." **National Geographic,** April 1984 pp. 465-488.

170/ The U.S. legislation is elaborate, including a ' Marine Mammal Protection Act, an Endangered Species Act, a Marine Protection Research and Sanctuaries Act, an Anadromous Fish Conservation Act and a Coastal Zone Management Act. See, inter alia, J. Hudnall, "A Report on Humpback Whales near Hawaii, and the need for the creation of a Whale park" **Oceans,** vol. 11(2), March-April 1979, pp.8-15.

171/ Many states within the Union have been active in setting land aside, for example, in the Chesapeake Bay area by Maryland, in collaboration with the National Capital Park and Planning Commission. See, e.g., R. Dolesh, "Lord of the Shallows, the Great Blue Heron" **National Geographic** April 1984, pp. 540-554. The Chesapeake has 8,000 miles of tidal shoreline and 150 tributaries. It has been one of the world's most productive estuaries. The extensive coastline of the U.S. happens to have a great many complex and productive estuaries; the country's industrialized status has resulted not only in substantial damage but also in numerous technical studies and instructive governmental responses.

172/ Veneto, Regional Act No. 53 of 8 November 1983, Articles 3 and 6, in **Gazzetta Ufficiale** No. 351 of 23 December 1983, p. 9832.

173/ Wild and Scenic Rivers Act 1968, P.L. 90-542, 82 Stat. 906.

174/ Water and Soil Conservation Act 1967, as amended, section 20D.

175/ For example, the Allagash River, in the interior of the State of Maine has been so designated under the U.S.'s programme. The Allagash is a tributary of the St. John River (which in one stretch forms the boundary between the U.S. and Canada), which empties into the Bay of Fundy through a complex estuary.

176/ 16 United States Code (U.S.C.) sections 1451-1464.

177/ 16 U.S.C. section 1453 (2).

178/ 16 U.S.C. section 1453(6).

179/ 16 U.S.C. section 1456(c).

180/ 43 U.S.C. sections 1331-1356.

181/ State of Louisiana Code, R.S. 49:21.31 to 49:213.21.

182/ **Ibid.** R.S. 49:213(2.1)

183/ Uses of State concern shall include, but are not limited to: a) any dredge or fill activity which intersects with more than one water body; b) projects involving use of State-owned lands or water bottoms; c) state publicly-funded projects; d) projects occurring in more than one parish; e) all mineral activities, including exploration for, and production of, oil, gas and other minerals, all dredge and fill uses, and all other associated uses; f) all pipelines for the gathering, transportation or transmission of oil, gas and other minerals; g) energy facility siting and development; h) uses of local concern which may significantly affect interests of regional, State or National concern.

184/ Uses of local concern include: a) privately-funded projects; b) publicly-funded projects; c) maintenance of uses of local concern; d) jetties or break waters; e) dredge or fill projects not intersecting more than one water body; f) bulkheads; g) piers; h) camps and cattlewalks; i) maintenance dredging; j) private water control structures of less than US$15,000 in cost; k) uses of cheniers, salt domes or similar land forms.

185/ State of Louisiana Code, R.S. 41: 1701-1714, Section 1703.

186/ **Ibid.,** section 1701.

187/ Official Code of Georgia Ann. sections 12-5-230 et **seq.** For discussion of the Georgia legislation, see C. Pendergrast, "The Georgia Shore Assistance Act' " **Natural Resources Lawyer,** vol. 17(3), 1984, pp. 397-411 and works there cited. See generally, J. Hoyt, **Barrier Islands and Beaches,** 1976; U.S. Army Corps of Engineers, **National Shoreline Study,** 1971.

188/ Code of Virginia, Title 62.1, Chap. 2.1, sections 62.1-13.1 through 62.1-13.20.

189/ Justinian, **Institutiones**, 2.1.4-2.1.6.

190/ Under the old English Common Law, saltwaters and waters subject to the flow and influence of the tides were "navigable" by definition; all other waters were, in law, nonnavigable, regardless of whether commercial or pleasure vessels in fact operated on them. "Tidewaters," then, meant navigable waters.

191/ See especially **Pollard v. Hagan,** 3 How (U.S.) 212; **Shively v. Bowlby,** 152 US 1; U.S. v. Oregon, 339 US 707; **Illinois Central Rr. v. Illinois,** 146 US 387; **Marks v. Whitney,** 6 Cal.3d 251; **Neptune City v. Avon-by-the-Sea,** 61 N.J. 296. Also J. Sax, "Liberating the Public Trust from its Historical Shackles," University of California at Davis Law Review, vol. 14, p. 184 **et seq.;** Note, "A Tidelands Trust for Georgia," Georgia Law Review, vol. 17, 1983, p. 851 et seq. A "public trust" criterion has recently been added to the permit system of California's State Water Resources Control Board for all new surface water allocations.

192/ See especially **Kaiser Aetna v. U.S.,** 444 US 164.

193/ Act No. 51 of 9 September 1981, Articles 11, 12.

194/ Law No. 86-2 of 3 January 1986, Article 146-4(111) and (IV), and Article 146-7, **Journal Officiel de la République Française,** 4 January 1986, p. 200.

195/ Act 317 of 22 May 1985.

196/ **Ibid.,** section 2.

197/ **Ibid.**

198/ **Ibid.**

199/ And above the tidal reach of saltwater, riverine.

200/ But even in the U.S. Anadromous Fish Conservation Act amendment of 1970, where supplementary provision is made for co-operative agreement among the Federal Government and two or more states having in any "basin" a common interest in carrying out research and development "to conserve, develop, and enhance anadromous fishery resources...", the term "basin" is defined to include "rivers and their tributaries, lakes, and other bodies of water..." 84 Stat. 214, new subsection (c). No specific mention of estuaries, or of marine waters used for migration, signifies a limited, freshwater orientation, insufficient when contemplating anadromous fishery conservation, development and enhancement.

201/ 179 Stat. 1125, 84 Stat. 214.

202/ Section 6, 79 Stat. 1125. Emphasis added.

203/ See, for some of these tasks, W. Queen, "Human Use of Salt Marshes" in **Wet Coastal Ecosystems,** V. Chapman, ed., Amsterdam: Elsevier, 1977, pp. 363-368; G. Rounsfell, "Realism in the management of estuaries", **Marine Resources Bulletin** No. 1, 1963; V. Chapman, "Coastal Zone Management in New Zealand", **Coastal Zone Management Journal,** vol. 1(1), 1974, pp. 333-345; H. Ponder, **Survey of State Coastal Management Laws,** Baltimore, The Johns Hopkins University Press, 1974; R. Walker, "Wetlands preservation and management of Chesapeake Bay"; **Coastal Zone Management Journal,** vol. 1(1), 1973, pp. 75-101; P. Cullen, Coastal Zone Management in Australia", **ibid.,** vol. 10(3), 1982, pp. 183-211.

204/ Moreover, in their own drive for integrated management, some specialists will be pulling for separate administrations for each subsector. for example, "A special body for water pollution control should be set up for each international drainage area". Para. 12 of Guiding Principles Applicable to Fresh Water Pollution Control, of recommendation 436 (1965), Consultative Assembly of the Council of Europe, Report on Fresh Water Pollution Control in Europe (Doc. 1965). But of course, the intention in that case was to avoid uncoordinated national bodies.

205/ See, **inter alia, Integrated River Basin Development,** New York: 1970, U.N. pub. Sales No. E.7-II.A.4; Water Resources Planning Experiences in a National and Regional Context, U.N. doc. TCD/SEM. 80/1; Uso **conjunto de aguas superficiales y subterraneas,** Mendoza (Argentina): Instituto de Economia, Legislacion y Administracion del Agua, 1976.

206/ See, **inter alia,** G. Cano, **Derecho, politica y administración ambientales,** Buenos Aires:1978.

207/ See, **inter alia,** J. Heikoff, **Coastal Resources Management: Institutions and Programs,** Ann Arbor, (USA): Ann Arbor Science Pub., 1977; R. Ditton, **et.al., Protecting the Golden Shore,** Washington, DC: The Conservation Fund, 1978.

208/ See, **inter alia,** P. Cullen, "Coastal Zone Management in Australia", **"Coastal Zone Management Journal",** vol. 10(3), 1982, pp. 183-211; P. Harrison and W. Sewell, "Shorelines Management: The French Approach", **ibid.,** vol. 5, 1979, pp. 161-180 and their "Shoreline Management in France: A Comment on Recent Regulations", **ibid.,** vol. 8(3), 1980, pp. 257-262 (including the new law on "Conservatoire de l'espace littoral et des rivages lacustres" or "shorelines trust"); R. Warren, et al., "Local Regional Interaction in the Development of Coastal Land Use Policies", ibid., vol. 3(4), 1977, p. 330.; L. Craine, "Institutions for Managing Lakes and Bays", **Natural Resources Journal,** vol. 2(3), 1971, pp. 526-546; British Columbia (Canada), Habitat Protection Division, Recreation Work Group, **Squamish Estuary Management Plan,** 1971; D. Finn, "Interagency Relationships in Marine Resources Conflicts: Some Lessons from OCS Oil and Gas Leasing", Harvard **Environmental Law Review,** vol. 4, 1980, pp. 359-390; Council on Environmental Quality (U.S.), **Oil and Gas in Coastal Lands and Waters,** Washington, D.C., 1977; Carroz, "Institutional Aspects of Resources Management in the Mediterranean", **Ocean Management,** vol. 3, 1979, pp. 235-251.

209/ See "The Land: Seeping Poisons" in **Environment and health,** Washington, D.C., Congressional Quarterly, 1981, pp. 27-40. See also, FAO, **Environmental Impact Assessment and Agricultural Development,** Rome, 1982 (FAO Environment Paper No. 2); J. Krupa, **Water Quality Legal Issues and Land Use in a Snared Estuary,** Kingston, RI(USA): University of Rhode Island, 1980. Incidentally, economically more valuable land uses in the coastal zone may drive out established agriculture, giving rise to disturbances in the established estuarine balances. Legal devices may deliberately be employed to retain agricultural uses. See L. Rea, "Agricultural Land Preservation: The Case of Carlsbad, California", **Coastal Zone Management Journal,** vol. 10 (1/2), 1982, pp. 141 **et seq.**

210/ See, e.g., J. Pedrick, Jr., "Land Use Control in the Coastal Zone: The Delaware Example", **Coastal Zone Management Journal,** vol. 2(4), 1976, pp. 345-366.

211/ There can be very complex considerations compelling such collaboration. See, e.g., W. Davoren, "Tragedy of the San Francisco Bay Commons", **Coastal Zone Management Journal,** vol. 9(2), 1982, pp. 111-147; **San Francisco Bay, the Urbanized Estuary,** T. Conomos, ed., San Francisco, American Association for the Advancement of Science, Pacific Division, 1979.

212/ The tailoring of legislation and agencies to be adequate to their assigned tasks and responsibilities is a persistent problem not examined here. But see especially **Experiences in the Development and Management of international River and Lake Basins, op. cit.; Interjurisdictional River Basin Administration,** Mendoza (Argentina): Instituto de Economia, Legislacion y Administracion del Agua, 1976; **Management of International Water Resources: Institutional and Legal Aspects,** New York 1975, U.N. Pub. Sales No. E.75.II.A.2; T. Hennessey, "Hightide, Theory and Coastal Zone Management", **Coastal Zone Management Journal,** vol. 5(4), 1979, p.259 et seq.

213/ See **The Coastline,** R. Barnes ed., Chichester (U.K.): Wiley, 1977; J. Clark, **Coastal Ecosystem Management: A Technical Manual for the Conservation of Coastal Zone Resources,** New-York: Wiley, 1977.

214/ See V. Chapman, "Chesapeake Bay and its Management", Proceedings, New-Zealand Ecol. Soc. vol. 23, 1976,"pp. 1-7; W. Pequegnat, "Aquatic Baseline Studies for Environmental Assessment", **Water International,** vol. 8(4), 1983, pp. 180-190; P. Weyl, "Pollution Susceptibility: An Environmental Parameter for Coastal Zone Management, "Coastal Zone **Management Journal,** vol. 2(4), 1976, pp. 327-343. For specific guidelines, see R. Burchell and D. Listokin, **The Environmental Impact Handbook,** New Brunswick, N.J. (USA): Center for Urban Policy Research, 1975.

215/ A certain quantity of sediment is required to provide nourishment to submerged aquatic vegetation and to benthic and marsh organisms. But "too much sediment fills in marshes and other shallow habitats and often requires dredging where navigation channels are present." N. Benson, "The Freshwater-inflow-to Estuaries Issue", **Fisheries,** vol. 6(5), September-October 1981, p. 9.

216/ Many inland water developments so modify the freshwater supply as to decrease estuarine productivity substantially. Too much water and too rapid runoff, on the other hand are also harmful: "Freshwater inflow to estuaries has been altered by construction of upstream reservoirs, by construction of levees along rivers for flood control, by dredging rivers for navigation, by diversion of water for agricultural, industrial or municipal purposes, by pollutants, and by changes in land use that increase the rate of runoff and sediment load of rivers. Reservoirs modify freshwater inflow primarily by trapping sediment and changing the natural seasonal flow regime... The spawning and nursery cycles of many fish and shellfish as well as many ecological production processes are closely associated with high spring runoff". Benson, **loc. cit.,** pp. 8-9. See also N. Armstrong and M. Hinson, Jr., "Influence of Flooding and Tides on Nutrient Exchange from a Texas Marsh" in **Estuarine Interactions,** M. Wiley, **ed.,** New-York: Academic Press, 1978, p. 365 **et seq.**

217/ See W. Schroeder, "Riverine Influence on Estuaries: A Case Study" in **Estuarine Interactions, op. cit.,** pp. 347-364.

218/ See J. Stevens and H. Chadwick, "Sacramento-San Joaquin Estuary-Biology and Hydrology", Fisheries, vol. 4(4), pp. 2-6 (1979); S. Hopkins**, Annotated Bibliography on Effect of Salinity and Salinity Changes on Life in Coastal Waters,** College Station, Texas: Texas A and M. University Research Foundation, 1973.

219/ See **Water Rights, Scarce Resource Allocation, Bureaucracy, and the Environment,** Anderson and J. Hirschleifer, eds., San Francisco, California: Pacific Institute for Public Policy Research, 1983, especially Chap. 8 ("Instream Water Use, Public and Private Alternatives" by J. Huffman), p. 249f.

220/ Benson, **loc. cit.,** p. 10.

221/ **The Economic and Social Importance of Estuaries, Washington, D.C.:** Environmental Protection Agency Water Quality Office (USA), 1971.

222/ See L, Falk, "Estuarine Management - Users' Needs" in **Estuarine Interactions, op. cit.,** pp. 37-56.

223/ H. Cole, "Marine Pollution - Facts and Fiction, the Situation in Britain", **Ocean Management,** vol. 5, 1979, pp. 263-278 at 266. Exceptions are the man-made chlorinated hydrocarbons, which, because they are chiefly airborne, may be distributed worldwide, **Ibid.**

224/ **Ibid.**

225/ **Ibid.,** pp. 266, 275 and 276.

226/ C. Sinderman, "Effects of Coastal Pollution on Fish and Fisheries" in **Middle Atlantic Continental Shelf and the New York Bight,** Special Symposia, American Soc. of Limnology and Oceanography, vol. 2, M. Gross, ed., Lawrence, KA (USA): 1976, pp. 281-301, at 283. On coastal pollution generally, see, **ibid.,** esp. "Overview" by M. Gross, pp.

1-13; "The Impact of Pollution on Marine Bathing Beaches", by V. Cabelli, **et. al.,** pp. 424-432; "Safe Shellfish from the Sea", by J. Verber, pp. 433-440. Also W. Bascom, "Beaches", **Scientific American** (August 1960) reprint, 11 p.; R. Barber and R. Smith, "Coastal Upwelling Ecosystems", in Analysis **of Marine Ecosystems,** Longhurst, ed., London: Academic Press, 1981, pp. 31 et seq.; International Technical Conference on the Conservation of the Living Resources of the Sea, Rome (FAO), 1955, U.N. doc. A.CONF.10/7, 1955, and A/CONF.10:5; C. Yonge, **The Sea Shore,** 1975; **The Water's Edge, Critical Problems of the Coastal Zone,** B. Ketcham, ed. 1972. On coastal reef problems, see R. Johannes, "Coral Reefs and Pollution" in **Marine Pollution and Sea Life,** M. Ruivo, ed., Rome: FAO, 1972, pp. 364-375.

227/ Additional mainly undisturbed, large estuaries, often with an "internal" delta, include the Ob River, the Anadyr, the Amur, the Yenisei, the Pur-Taz and the Jatanga in the U.S.S.R. In the Artie region, other quite elaborate, undeveloped deltas exist, such as those of the USSR's Lena (emptying into Laptev Sea) and Indiguirka (East Siberian Sea) Rivers. In Canada the huge MacKenzie River delta discharges unmolested into the Beaufort Sea Via MacKenzie Bay; in this region, however, petroleum exploration and development may soon introduce significant disruption. The delta of the Yukon River in Alaska fronts undisturbed on Norton Sound.

228/ A. Heydorn, "Coastal Zone Management and Conservation", **Ocean Management,** vol. 4, 1978, pp. 303-317 at 317.