Intergovernmental Oceanographic Commission
Workshop report no. 11

Report of the IOC/FAO/ UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions

Port-of-Spain, Trinidad
13-17 December 1976

Unesco

The Scientific Workshops of the Intergovernmental Oceanographic Commission are usually jointly sponsored with other intergovernmental or non-governmental bodies. In each case, by mutual agreement, one of the sponsoring bodies assumes responsibility for publication of the final report. Copies may be requested from the publishing bodies as listed below or from the Secretary IOC, Unesco, Place de Fontenoy, 75700 Paris, France.

No.	Title	Publishing Body	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia /Report of the IDOE Workshop on/; Bangkok, Thailand, 24-29 September 1973. UNDP (CCOP), 158 p.	Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok 2, Thailand	English
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974. (Unesco Technical Paper in Marine Science, No.20).	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
4	Report of the Workshop on the Phenomenon known as "El Niño", Guyaquil, Ecuador, 4-12 December 1974.	FAO Via delle Terme di Caracalla 00100 Rome, Italy	English Spanish
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
7	Report of the Scientific Workshop to initiate planning for a co-operative investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/EAC, Nairobi, Kenya, 25 March - 2 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	Full text (English only) Extract and Recommendations: French Spanish Russian

No.	Title	Publishing body	Languages
8	Joint IOC/FAO(IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
11 Suppl.*	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish

---

* This is published separately from the main Workshop report, and will appear about three months later.

1. Opening of the Workshop

The International Workshop on Marine Pollution in the Caribbean and Adjacent Regions was held in Port-of-Spain, Trinidad, from 13 to 17 December 1976, under the auspices of the Intergovernmental Oceanographic Commission (IOC), the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP). The Workshop was formally inaugurated by the Chairman, Dr Julian Kenny, after which Mr Lennox Ballah welcomed the participants in the name of the government of Trinidad and Tobago. Mr Ballah pointed out the importance that Trinidad and Tobago attached to a regional effort to combat pollution of the marine environment. Following these words of welcome, Mr R.C. Griffiths, Assistant Secretary of the IOC, thanked the government of Trinidad and Tobago for hosting the meeting and welcomed the participants on behalf of the three co-sponsoring UN bodies. Afterwards he briefly outlined the scope of the Workshop and emphasized that its main objectives were to identify the major marine pollution problems of the region and recommend a set of priority actions which would lead to a better understanding of them.

The Agenda of the Workshop is attached as Annex I.

1.1 Election of Officers

Dr Donald Atwood proposed Mr Jorge Corredor as rapporteur to the Workshop and was seconded by Dr Enrique Mandelli and Mr Vasquez Botello. Mr Corredor was elected unanimously. Dr Julian Kenny then proposed Dr Donald Atwood as Vice-Chairman; he was elected unanimously. The list of participants is attached as Annex II. The agenda was then presented by the Chairman of the Workshop, Dr Kenny.

1.2 Initial discussions

Dr Stjepan Keckes of UNEP explained briefly the principles used by UN in dealing with the environmental problems in marine regions such as the Caribbean. The basic characteristic of this approach is its comprehensiveness and complexity in which environmental protection is not viewed simply as environmental conservation but as a dimension of socio-economic development.

He then explained that UNEP had taken some preliminary steps to develop a regional Action Plan for the wider Caribbean Region. Such a Plan could comprise the following subjects: protection of the marine environment; promotion of environmental health; human settlements; tourism; industrial, technological and natural resources development; natural disasters. The Action Plan would be developed in co-operation with the Economic Commission for Latin America (ECLA). The relevant parts of the UN system are expected to provide full assistance in the development and eventual implementation of the Action Plan. He stated that the Action Plan will be formulated in close consultation with the

governments of the region and will take into account the realities, needs and possibilities of the region. Once formulated, the Action Plan would be presented for discussion, modification and approval, to a Caribbean intergovernmental conference to be convened at the highest possible political and technical levels towards the end of 1978.

In view of the special importance of the marine environment, he stated that although the Action Plan will basically emphasize the management of the coastal developmental problems, the protection and management of the marine environment and its resources will receive due attention. In this context he pointed out that this Workshop would play a central role in identifying priority problems related to marine pollution in the wider Caribbean region and in proposing priority activities or measures which could be incorporated into the Action Plan. The implementation of certain activities proposed by the Workshop might start in 1977, pending the views of the governments of the region. As the work recommended by the Workshop should be undertaken almost exclusively by the experts and institutions of the region, a massive training programme and a strengthening of the capabilities of national institutions could be the first steps to be undertaken with the assistance of the relevant specialized bodies of the UN system.

Several of the participants expressed their doubts that a group of trained scientists from the region could be prepared before the end of 1978. To accelerate the identification of training needs, it was proposed that the Workshop report include a call to the governments of the area to consider their needs in the light of the recommendations of the Workshop, and to communicate these to the organizing agencies.

Finally, Dr Keckes stressed the delicate political nature of pollution programmes and the consequent necessity of having the full endorsement of the governments involved.

Mr Marian Fila, the representative of the Intergovernmental Maritime Consultative Organization (IMCO), informed the participants that his organization, with the support of UNEP, was at present planning to hold a course on prevention, abatement and combatting of pollution from ships for the region. He indicated that the course would primarily deal with oil pollution problems and would adhere to the framework established in the 1954 International Convention for the Prevention of Pollution of the Seas by Oil (as amended in 1962) and of the 1973 Convention for the Prevention of Pollution from Ships.

Dr Bogdan Kwiecinsky noted that such courses were also available to Caribbean and Latin American scientists at the U.S. Coast Guard Reserve Training Center, Yorktown, Virginia, USA.

2. Invited Lectures

Eight special lectures on topics related to the main questions of marine pollution in the Caribbean were presented.

2.1 Dr Ingvar Emilsson presented the first paper, entitled: "Regional oceanography as it relates to present and future pollution problems and living resources: Gulf of Mexico."

He briefly described the main physiographic features of the Gulf, followed by the main features of the horizontal circulation which is characterized by a strong flow through the Yucatan channel. This current, after flowing more or less northward, turns eastward in a loop and issues through the Straits of Florida. The loop current is highly variable in strength and direction. The western Gulf is characterized by relatively large eddies generated, at least initially, by the loop current from which they separate in the northern part of the Gulf. Wind stress is particularly important over the shallow shelf areas of the Gulf, and tidal currents are important in spite of small tidal ranges. There are therefore comparatively complicated water movements inshore, especially near the mouths of rivers. Tidal currents are particularly important in the flushing of coastal bays and lagoons.

Vertically, the surface layer in the Gulf is highly stratified, especially in the western and central regions. The mixed surface layer varies from about 30m. in summer to 75m. in winter. A thin layer of water supersaturated in oxygen is often observed in spring and summer at 30-35m. depth. Reduced temperature and increased salinity in winter lead to vertical mixing and the erosion of this layer. Hurricanes and strong northern winds are an important factor in vertical mixing. However, such mixing is limited over shallow shelf areas. Exchange of water with deep or offshore water is quite small, especially in winter.

There is a salinity maximum at 100-200m. depth due to subtropical subsurface water from the North Atlantic. This water may reach the surface in Campeche Bay, and off the Texas and West Florida shelves. There is neutral stability below the sill depth (about 2,000m.) but high oxygen values show that vertical mixing takes place in the basin.

However, the deep water of the Gulf has practically identical characteristics to that of the Cayman Sea, suggesting that water above sill depth moves mainly horizontally with limited vertical mixing. This makes the Gulf an unusual semi-enclosed basin inasmuch as it is well stratified, yet each layer, even below sill depth, exchanges water with the outside at an appreciable rate. This is probably best explained by the topography of the entrance in the Yucatan Channel and the high energy of the incoming water.

Discussion

It was noted that, in certain coastal areas of the Gulf, such as the Campeche Bank, relatively long residence times of waters could be expected, with a relative concentration of pollutants as a possible consequence. Despite such isolated cases, it was noted that the residence time of certain pollutants in the Gulf surface waters could be of the order of decades. The residence time of pollutants in deep water (below the Cayman Sill) appears, however, to be unknown, and a better understanding of transport across the sill is required before this

question can be satisfactorily answered. It was also noted that transport back from the Gulf to the Caribbean was possible but that its magnitude was probably not known.

A concrete question was the possible fate of a major oil spill in the Gulf. Dr Emilsson was of the opinion that such a spill could be washed up on the beaches or trapped along them for a relatively long time owing to the nature of the cyclonic eddies breaking off the loop current systems. The typical life time of such eddies was thought to be in the region of 100 days.

It was also noted that, as a consequence of the large-scale circulation of the Northern Atlantic, major pollution events in the Caribbean Sea and the Gulf of Mexico might have an effect upon European waters.

2.2 Dr Donald Atwood presented a paper entitled: "Regional oceanography as it relates to present and future pollution problems and living resources - Caribbean".

He described briefly the bathymetry of the Caribbean, all the basins of which are much deeper than the deepest sills (Windward and Jungfern, in the Antilles). Below the surface mixed layer, which is strongly affected by currents, are two main water masses: one centred about a salinity maximum at about 175m. depth - subtropical underwater; one centred about a salinity minimum at about 800m. depth - subantarctic intermediate water.

It is still not clear how much or how fast water in the basins below sill depths is replaced. Evidence from observations of dissolved oxygen and silicate suggest that the replacement is appreciable though probably sporadic. At the surface the north equatorial and the Guyana (south equatorial extension) currents are the sources of the Caribbean surface currents. The two source currents join to form the Caribbean current although there are two main branches (14^{o}-16^{o}N and 12^{o}-$13^{o}30'$N) with velocities of more than 40cm./sec. and 60 cm./sec., respectively. There is significant flow down to 500m. depth but not below.

Temperature and salinity contours move close to the surface in the southern Caribbean where upwelling often occurs; these isopleths also turn slightly towards the surface in the north, owing to an eastward-flowing countercurrent.

The Amazon and Orinoco rivers contribute significant amounts (up to $200 \times 10^{3} m^{3}$/sec) of fresh water to the surface waters of the Caribbean. The silica content of the Caribbean surface water varies inversely with salinity showing the fluvial source of the freshwater. Fine layers of sediment originating in the Amazon and Orinoco rivers are found suspended at certain depths.

The southwestern Caribbean is also affected by seasonal rainfall.

Since the water in the Caribbean has many sources, pollution of them presents a potential danger to the Caribbean. Development of the Amazon and Orinoco basins could be, in the future, very important in this sense.

Increasing pollution of deep water that is not readily replaced could also become a critical problem.

Discussion

It was noted that deep Caribbean waters may be subject to only sporadic removal. Hence, a major concern was that anoxic conditions might result if a large amount of organic material were to sink into the deep basins below the sills. The influence of Amazon and Orinoco waters on the surface waters of the Caribbean was pointed out, and it was noted that future major pollution from these river basins could have a strong effect upon the Caribbean.

2.3 Dr Enrique Mandelli presented a paper entitled: "Pollution research and monitoring for heavy metals."

Dr Mandelli described briefly the occurrence of metals in natural waters. Transition metals tend to be reactive and so accumulate in minerals and organisms. Copper and zinc have specific biochemical functions, whereas silver, cadmium and mercury are biochemical hazards. More lead is mobilized by man than by nature, and the effect on organisms could be both somatic and genetic. Certain amphoteric elements like selenium and arsenic are mobilized by microorganisms and their organo-metallic compounds may be ecologically significant. It is often very difficult to establish the prevalent metal species in natural waters.

Weathering and vulcanism are the predominant natural processes transferring trace elements from the continents to the oceans. Land erosion, due to intensive use by man, and the disposal of wastes are the main cultural processes. The latter processes constitute about one tenth the mobilization due to weathering.

Rivers are the major pathway, exceeding glaciers, in this respect, by ten times and winds by one hundred times. It is very difficult to measure the trace-element composition of streams, owing to strong regional and seasonal variations and to substantial cultural mobilization via the streams. At least five mechanisms operate in the transport of trace elements by rivers. However, results for the very different Amazon and Yukon rivers with respect to each of these mechanisms were surprisingly similar.

Atmospheric transport is mainly through aerosols, of which sea salt and continental dust are the main components (not necessarily together). High temperature processes (vulcanism, combustion of fossil fuels and production of cement in particular) contribute the more volatile metals to the atmosphere, either as gases or small particles. The particles settle

into the sea or are washed into it by rain, snow, sleet etc. The atmosphere tends to distribute its particulate load relatively rapidly throughout its main bulk, especially within each of the main wind zones.

Direct input of metals from coastal outfalls in populated regions is often significant (e.g. up to one quarter of all inputs into a given sea area). Dumping can also be locally very important.

Dr Mandelli described in some detail the fate of metals in the marine environment, starting from their chemical speciation. Adsorption, precipitation, colloidal flocculation and biological uptake remove metals from the water and tend to transfer them to the sediments, but there is also some accumulation in the surface microlayer.

Biotransformation such as methylation and so-called redox reactions catalyzed by enzymes in micro-organisms lead to detoxification of these organisms. Mercury, tin, palladium, platinum, gold, thallium and arsenic can all be methylated; lead, cadmium and zinc cannot. Sea grass is an effective methylator of mercury.

Bioaccumulation temporarily removes metals from the water, and some organisms may permanently fix some metal in their tissues. It was pointed out that some metals may be pre-concentrated in organic and inorganic particulates that are then ingested by organisms.

The effects of pollutants on marine biota were briefly discussed, both primary (e.g. contamination and alteration of behaviour) and secondary (e.g. alterations of the ecosystem). Reference was also made to effects on fisheries and human health.

Dr Mandelli closed by mentioning the basic requirements of monitoring.

Discussion

A main concern was the behaviour of heavy metals in estuarine areas. It was pointed out that there was a particular need for knowledge concerning the speciation of heavy metal compounds and ions in water and sediments. This was considered especially important in view of the fact that the degree of toxicity of heavy metals is highly dependent on their chemical state. It was noted that little is known concerning the input of these pollutants through the atmosphere. Although he did not identify any one specific element of special concern in the wider Caribbean area, Dr Mandelli pointed out that pollution resulting from mining, such as that for bauxite, should be given special consideration. He also indicated that the main source of pollution by trace elements in the area was to be found in domestic and industrial waste waters. Regarding the choice of organisms to be monitored for heavy metals and other potentially toxic oligo-elements, it was noted that the larger sessile organisms were generally preferred for monitoring purposes, and that the soft parts of such organisms were generally to be preferred over the hard parts.

2.4 Dr Eugene Corcoran presented a paper entitled: "Pollution research and monitoring for halogenated hydrocarbons and pesticides".

He noted that chlorinated hydrocarbons are one of the few kinds of substance that do not generally occur naturally. They are toxic in low concentrations, have a global distribution, and are extremely persistent. DDT is the oldest classic example. It has been used in the form of sprays, liquids, aerosols and paints. Its value as an insecticide is well known; its main defects are that it has lead to resistant insects and also kills beneficial species. This lead to the use of other chlorinated hydrocarbons or the invention of new ones. The most commonly used are: benzene hexachloride, heptachlor, dieldrin, endrin, aldrin, methoxychlor, mirex and chlordane.

Returning to DDT, Dr Corcoran described how DDT had affected many bird populations, usually through eggshell thinning. Derivatives of DDT (e.g. DDE) were also implicated.

Endrin has been found responsible for fish kills.

The monitoring of rivers over a long time period has shown that dieldrin and DDT and its related compounds are consistently the dominant pesticides reported. Yet results also began to show in several wildlife species that the content of chlorinated hydrocarbons exceeded that ascribable to pesticides. This lead to the revelation of polychlorinated biphenyls (PCBs), which had been hitherto obscured by the more familiar DDT compounds. PCBs are very persistent and nearly insoluble in water; otherwise they tend to follow the pathways of DDT. PCBs preferentially accumulate in biota and sediments, and are widespread.

A study of the Mississippi discharge showed that most of the DDT in the river water becomes bound in the sediments, and only a part enters the Gulf of Mexico. However, sediment-bound DDT can be remobilized by benthic organisms, by fishing or by other disturbances of the sediment. At the sea surface chlorinated hydrocarbons can be concentrated in slicks, affecting diving birds or being vapourized into the air.

The residence time of most chlorinated hydrocarbons in the atmosphere is now thought to be in the range of hours to days (e.g. 50 days) rather than years, though it depends a lot on the molecular weight of a particular chemical. Thus, the oceans are probably the main distributor of chlorinated hydrocarbons.

Some chlorinated hydrocarbons bioaccumulate; others do not, and much more research on this question is needed. There remain also many problems of sampling and analysis, recent developments, particularly in gas chromatography, notwithstanding. It seems advisable to measure total chlorinated hydrocarbons in environmental samples since all have some effect on organisms.

Discussion

The subsequent discussion made especially apparent the great difficulty in carrying out reliable analyses for halogenated hydrocarbons. Discussion indicated that while much is known regarding the pathways of these pollutants from their points of production and use into the marine environment, further

study is required. Regarding the safe disposal of halogenated hydrocarbons, Dr Corcoran indicated that, although incineration has been proposed, it was probably not as effective as dehalogenation since, in the former, a large fraction of the pollutants was vapourized and released into the atmosphere. Concern was also expressed about the possibility of these compounds being co-distilled and concentrated in drinking water produced in desalination plants in the region.

2.5 Dr Gunnar Kullenberg presented a paper entitled: "Pollutant transfer and transport in the sea".

Dr Kullenberg, in perhaps the most technical of the lectures, described the main physical processes by which contaminants are dispersed (uniformly distributed) in sea water: transport, by advection (or convection), causing a local change in concentration; and diffusion or random local rearrangement of water and contaminant without net transport of the contaminant by the water. He distinguished between absolute dispersion (that observed from a fixed point) and relative dispersion (that observed from a moving point).

It is impossible to define completely the field of motion in any substantial part of the sea, so average motion over appropriate time and space scales must be used. The averages measure advection (or convection), whereas the fluctuations about these averages measure the diffusion. The choice of appropriate time and space scales is vital to the elucidation of any given problem.

The physical dispersion of pollutants is influenced by such environmental factors as: wind, surface waves; radiation (incoming and outgoing), convection, evaporation and precipitation; salinity, temperature and density distributions; currents, tides and other rotational effects, turbulence (in three dimensions) and internal waves.

Dr Kullenberg defined some common scaling parameters under the concepts of boundary layers, turbulence and transfer coefficients. The chemical effects of salinity and temperature, such as flocculation, which can influence the gravitational settling velocity of solid material contained in sewage sludge, were not specifically discussed. It was only mentioned that the settling velocity in the flocculated state is about 1 m./hr. Turbulent transport at the sea surface is an order of magnitude greater, while vertical transport due to mixing in deep waters, in stratified fjords and enclosed seas is similar or somewhat less than gravitational settling velocity.

The difficulties of describing dispersion processes were emphasized, it being possible only to describe them approximately in a few simple situations. The sea can be considered under four zones: the surface layer, where atmospheric effects dominate; the pycnocline (thermo- or halo-) layer where bouyancy is a predominant factor; deep water where internal waves are a dominant factor and turbulence is generally weak; and the bottom water in which fruction with the sea floor is important.

Dr Kullenberg described the factors that would operate on a "cloud" of pollutant at the sea-surface, first under the assumption of a

negligible velocity gradient in the horizontal current (in which case only motion of the water on a scale larger than the "cloud" will advect it), and, second, under the assumption of appreciable vertical velocity gradient in the horizontal current (in which case the combination of vertical mixing and velocity gradient will generate an appreciable apparent horizontal diffusion).

In many coastal and shallow areas tidal oscillations and local winds are important energy sources. In such areas limits to the dispersion of pollutants are often established fairly rapidly.

Strong vertical density stratification is the chief factor in reducing turbulence, whereas wind stress on the sea surface (including wave action) is the chief factor in promoting it. The depth of the mixed layer, which reflects the opposition of these two factors, is often subject to considerable seasonal variations. At the main density gradient (pycnocline) bouyancy becomes the main force in determining vertical motion. Strong turbulence above the pycnocline tends to entrain water from below (i.e. erodes the pycnocline) usually but not necessarily decreasing the concentration of a contaminant in the upper mixed layer. Where two (or more) marked pycnoclines occur pollutants may become trapped between them and remain there for considerable periods of time.

Discussion

The question of the transfer of pollutants across the pycnocline in the Caribbean and adjacent regions was identified as one of special concern. It was noted that these waters were permanently stratified and that under these conditions pollutants introduced into the upper mixed layer would tend to stay there rather than be mixed into deeper waters. Another mechanism of trapping identified as potentially important to the Caribbean area was that brought about by coastal upwelling which could cause dangerous concentrations of pollutants discharged into these waters. The matter of sewage disposal into ocean waters was given ample consideration. It was noted that discharging into predetermined subsurface layers could remove sewage from sight, but such discharge was probably inadvisable since the sewage could become entrapped in these layers and adversely affect biological processes.

2.6 Mr Alfonso Vazquez Botello presented a paper entitled: "Pollution research and monitoring for hydrocarbons: present status of the studies on petroleum contamination in the Gulf of Mexico".

Mr Vazquez Botello summarized the available information on current research in petroleum hydrocarbons in the Gulf of Mexico. There are two main groups of hydrocarbons in the water: those of low molecular weight (1-10 carbon atoms) and those of high molecular weight (11 or more carbon atoms). Methane predominates in the first group and is of biogenic origin. The water concentration is about 35 µg./l., followed by those of ethene (6 µg./l.) and propene (2.6 µg./l.). Some coastal areas of Texas gave very much higher (up to six orders of magnitude) values than open-ocean waters. The main cause is believed to be petroleum production at offshore drilling sites.

The higher molecular weight hydrocarbons are divided into those in a particulate state, such as pelagic, littoral and abyssal tars, and those dissolved in the water. Pelagic tars are particularly important in the Gulf; their main sources are tanker and drilling operations. The comparatively weak circulation in the central and western parts of the Gulf maintains relatively high concentrations. Dissolved high-molecular-weight hydrocarbons are strongly concentrated in the surface microlayer.

Hydrocarbon (fossil plus biogenic) concentrations in the sediments vary widely from 12 ppt in highly polluted coastal areas to less than 100 ppm in unpolluted areas. Information is limited.

Whereas the information on hydrocarbons in sediments is sparse, that on hydrocarbons in marine organisms is even more so. Many marine organisms make their own hydrocarbons, obtain them from their food or convert precursor compounds obtained from their food. Certain organisms, such as benthic algae and sea grasses, from coastal areas of the Gulf of Mexico, have been analyzed for alkane content, and the hydrocarbon content of plankton and certain invertebrates from the region has been determined. Studies on effects of fossil hydrocarbons on the principle biological processes are now being made.

Discussion

It was noted that a major priority was the development of analytical techniques for assessing pollution loads which could be reliable and give reproducible results. Some techniques that have limited success, including fluorescence spectroscopy, isotopic ratio analysis and chromatographic finger-printing were mentioned. In this context, the necessity of being able to distinguish between natural hydrocarbons in the environment and those released by man was given high priority. Special mention was also made of the deleterious effect of detergents used in dispersing oil spills. It was noted that this practice had been discontinued in the Gulf of Mexico for this reason.

2.7 Dr Eric Mood presented a paper entitled: "Health aspects of coastal water pollution".

Numerous outbreaks of bacterial and viral infections have been traced to the consumption of raw or inadequately cooked molluscan shellfish, particularly clams, oysters and mussels taken from coastal waters polluted by untreated domestic sewage. Typhoid, paratyphoid and infectious hepatitis are the commonest of the diseases. Dr Mood gave several examples of such occurrences. In some cases absolute proof was not obtained but the circumstantial epidemiological evidence was strong. The difficulty lies in isolating the infective organism (particularly the virus of hepatitis) from the shellfish.

Paralytic shellfish poisoning from the consumption of raw clams and mussels arises from toxin from dinoflagellates consumed by the shellfish. Sometimes the rapid multiplication of these organisms is due to sewage discharge.

Bacterial infections predominate in diseases from eating contaminated fish and shellfish. However, there is little evidence to link fish-borne infections to pollution of coastal waters. For example, Vibrio parahemolyticus, the causative agent of over 50% of all food-borne diseases in Japan, is found in seawater and bottom sediments in unpolluted as well as polluted waters.

Mercury poisoning follows from a complex process: metallic mercury (or its salts) is discharged into the water and is methylated mainly in the sediments of the water body. Methylmercury is easily assimilated by fish and other organisms and when these are eaten by man, poisoning is likely to result, especially since methylmercury is only very slowly eliminated. Some sea grasses are now known to be active methylators of mercury.

Other metals may be concentrated, possibly by similar processes, making potential hazards to human health.

Persistent chemicals (e.g. pesticides and industrial halogenated hydrocarbons) are accumulated by some organisms and, if consumed in sufficient quantities by man, may give rise to chronic toxicity in man. However, far too little is known of this. Polychlorinated biphenyl has carginogenic properties and is therefore a potential hazard to human health.

Oil in organisms does not usually intoxicate human beings, but does taint food and may prejudice the essential diet of some human populations.

There is probably some hazard, due to infectious organisms, to human beings who swim in seawater into which untreated sewage is discharged. The factual evidence is scarce but inferential epidemiological evidence is stronger. Typhoid outbreaks have been thus ascribed in certain cases. Infections of the eyes, ears, nose and throat are commonest, followed by gastro-intestinal disturbances. They occur significantly more often in swimmers than in non-swimmers using polluted bathing areas. However, there is a lack of standardization in studies of this kind making it difficult to pool data.

Dr Mood emphasized also that visible beach pollution could be detrimental to a sense of well-being. There might also be a potential hazard from thermal discharge.

He then proposed a few basic criteria of coastal water quality.

Discussion

The main difficulty of establishing adequate water quality standards was the main subject of discussion. With respect of bacterial contamination, it was noted that Escherischia coli counts alone were totally inadequate. Dr Mood stated that such numbers could be useful only if accompanied by data on environmental parameters affecting the survival of pathogens. In reference to sewage treatment, it was noted that criteria for adequate treatment should be set with a view to the particular conditions prevailing in the area in question.

2.8 Mr Lennox Ballah presented a paper entitled: "Political aspects of marine pollution and development of political awareness of marine pollution problems".

Mr Ballah observed that the third U.N. Conference on the Law of the Sea had sharply focussed the political aspects of marine pollution. Policy decisions with respect to marine pollution must reflect scientific and technological realities; these decisions must not be piecemeal. Pollution control is required because pollution, far from being a product of development, is an obstacle to development in its fullest sense. Pollution is a product of ill-conceived development. There is therefore a great need to develop political awareness of pollution problems.

Knowledge and information about marine pollution derived from continuing scientific research and monitoring must be put into the decision-making process. Politicians must be given facts.

The process of economic development is largely the process of utilizing more and more energy to increase human productivity. The waste from human production pollutes the human environment. The great dilemma is how to develop without polluting. No country is likely to hold up its development until a solution is found. There are even cases where a highly polluting industrial activity is adopted by a developing country after it has been banned in a developed country in which it was formerly used.

Mr Ballah then addressed the question of pollution and innocent passage. Some states may eventually not allow innocent passage through their territorial waters of ships not meeting international pollution safety standards. It is a question of whether a real risk of pollution from a ship in transit is or is not prejudicial to the peace, good order or security of the coastal state. In some cases it may be a question of whether control of pollution (or potentially polluting) ships is comprised by the enforcement of sanitary regulations. The main difficulty lies in defining 'innocent' in this context and whether an act of pollution need only be wilful as a ground for preventing innocent passage.

Wider problems arise whenever a state has established an exclusive economic zone (EEC; usually out to 200 miles from the coastal baseline). Mainly with a view to protecting living resources, many countries would like to extend their control over potential pollution sources to the whole of the EEC.

A particular difficulty arises as to who should have the jurisdiction over a cargo vessel or oil tanker: the flag state of the vessel, or the coastal state in whose waters the vessel may be travelling when it causes pollution. Hitherto, flag states have predominated.

The root of many of the difficulties is whether the open-ocean belongs to everyone or to no-one. Historically, the latter view has prevailed and has been taken advantage of by polluters who consider they are answerable to no-one. This view has been formally challenged in the UN.

The situation regarding responsibility and liability for marine pollution is also unclear, and a very difficult area of international maritime law.

Mr Ballah closed with the question of developing public awareness. To be informed is to be aware. Such information must be presented to the public in an appropriate way at all levels. Often the difficulty is to establish in the public's mind the connection between the sources of pollutants in one place (on land, for example) and the effects in another (out at sea, for example). The public must be moved by the facts to demand action. Preservation of the marine environment must become a primary national objective. The greatest impact on the public can probably be made through the young before they form life-long habits. All types of communications media should be used.

And the establishment and development of marine scientific research and monitoring programmes must underlie all these activities.

3. Plenary debates

3.1 Regional marine pollution problems

The Chairman invited the participants to address themselves to the pollution problems of the area, taking care to follow the guidelines in the annotated agenda. He recommended that two major aspects be held in mind: that of pollutants that are dispersed through the region and that of pollutants that are restricted to specific areas but are common to many countries in the region. The participants were also asked to keep in mind the review of major pollution problems in the region which was prepared by FAO using information provided by the governments of the region. Dr Wenblad made a brief presentation of this review.

The following pollution problems were considered to be of gravest concern: petroleum hydrocarbons, heavy metals, halogenated hydrocarbons, pesticides, sewage, suspended artificial particulate pollutants, such as asbestos and red muds, solid plastic wastes, fresh water intrusion, effluents from milk and meat processing, and changes in water regimes caused by the installation of power plants and other engineering works in the coastal area. It was made clear that the pollution problem of gravest concern was that caused by the release of petroleum hydrocarbons into the marine environment.

The special situation of the eastern Caribbean islands was mentioned. These islands are bathed directly by the Atlantic Ocean and therefore receive directly the pollutants therein. At the same time their capacity for dealing with such pollution problems (particularly those due to oil) is still small.

Discussions then turned towards the general approach that should be used. It was pointed out that governments should be approached with statements of the probable economic impact of the different pollution problems. It was also noted that the loading capacity of especially fragile zones such as coastal lagoons, estuaries, mangroves, coral reefs

and river deltas should be well studied. In this manner, the relative vulnerability of different ecosystems could be established and the adverse effects of pollution could be minimised.

Dr Luis Garcia pointed out that the quantity and seasonal variation of rainfall in the Central American isthmus depends largely on the moisture carried inland by the northeast trade winds. It is believed that the major moisture source is the Caribbean sea. Substances, such as hydrocarbons, that form thin layers on the water surface might interfere with the evaporation process and thus alter this ocean-atmosphere balance. The Workshop recognized the need to study this potentially serious problem.

The Workshop also recognized the need for contingency arrangements in the region for dealing with massive oil spills, particularly with regard to the development of methods for dealing with oil spills, to the availability of equipment and materials, to co-operative arrangements and to the training of personnel.

Throughout these discussions, repeated reference was made to the urgent need for training, education and mutual assistance (see section 3.3).

3.2 Proposals for regional research and monitoring programmes

In consideration of the priorities and approaches expressed, it was decided to treat the problem of petroleum pollution in plenary and then to divide the Workshop into three working groups to treat three sets of problems: (1) Health aspects of marine pollution; (2) Coastal processes related to the transfer and mixing of pollutants; (3) Effects of marine pollution on living resources. Mr Arthur Archer, Lt. Rafael Steer and Dr Barry Wade acted as chairmen of these three working groups respectively.

The Workshop proposed seven projects: the project on oil was accorded overall priority. The working group on health aspects of marine pollution proposed one project; the working group on coastal processes related to marine pollution proposed two projects, without giving either priority; and the working group on effects of marine pollution on living resources proposed three projects, arranged in order of priority.

OIL POLLUTION

In the discussions on oil pollution, it was made clear that scientific studies should provide knowledge concerning the sources, fate and effects of petroleum released in the Caribbean area. The need to establish the secondary effects caused by different oil pollution combatting procedures was also mentioned.

Mr Alfonso Vazquez Botello was invited to chair a drafting group to draw up a proposal for joint activities related to this topic, keeping in mind the concerns and ideas expressed during the plenary debates.

The following proposal was adopted by the Workshop.

Title of project

Sources, effects and fates of petroleum and petroleum products in the Caribbean, Gulf of Mexico and adjacent regions.

Background and justification

The preservation of the quality of the marine environment is of vital importance to the countries in this area, because the sea as a natural resource is of paramount importance to tourism, recreation and the provision of food. On the other hand, this region is also an area of high oil production and transportation; there are few data on the qualitative, economic and productive impacts that oil pollution has on these natural resources.

Objectives

Short-term objectives

(a) To undertake baseline studies to determine the present state of oil pollution in marine and estuarine organisms, in coastal areas, including the shoreline, water column and ocean floor, and in recent sediments.

(b) To investigate the ecological effects of oil pollution on marine and estuarine communities of biological importance.

(c) To identify the biological systems that are most vulnerable to chronic and acute oil pollution.

(d) To supply the necessary scientific basis for formulating comprehensive regional contingency plans to cope with oil spills.

Long-term objectives

(a) To identify, qualitatively and quantitatively, the main pathways of petroleum hydrocarbons into the Caribbean, Gulf of Mexico and adjacent regions.

(b) To assess the effects of oil pollution on coastal and marine resources such as exploited fish stocks, recreation, tourism etc.

(c) To investigate the physical, chemical and biological fate of oil in the marine environment.

(d) To examine critically the use of oil dispersants.

HEALTH ASPECTS OF MARINE POLLUTION

A wide range of pollutants that are known to enter the Caribbean marine environment were considered and those that were not related to known diseases in man were eliminated from consideration. Similarly eliminated were pollutants such as PCBs and radioactive wastes where either epidemiological records do not support a causal hypothesis or specific disease, or where no considerable industry is present in the region to pose a marine waste disposal problem.

The remaining pollutants affecting man in the region were examined and it was determined that pathogens were the most common pollutants and cause of infection in man through the ingestion of infected seafood or oral intake of infected water during sea bathing.

The probability of man bio-accumulating certain pesticides and heavy metals was also considered. It was felt, however, that without reliable epidemiological information on illness due to such bio-accumulation, undertaking large-scale measures for identifying specific pollutants and recommending control guidelines was neither justifiable nor economically feasible at this time.

The project given below was selected because of its relevance and importance to all countries in the region. Several aspects of the project were discussed:

(a) collection of data pertaining to marine pollution and enteric illnesses, particularly those resulting from the consumption of infected shellfish;

(b) the infrastructural, equipment, and manpower requirements for the surveillance, analysis, reporting and administrative components of the project;

(c) the monitoring, surveillance, and laboratory examination programmes required for determinations of the quality of marine bathing waters and areas where aquaculture is practised; and

(d) the need for the development of regional recommendations to governments on guidelines for improvement of treatment and disposal of sewage and industrial wastes.

To achieve the desired measure of success in a regional project of the kind proposed, it was agreed that, because of the vast marine area involved, and the complexity of meteorological and oceanographic conditions that influence the fate of sewage and industrial wastes discharged into the ocean, complementary sub-regional projects will become necessary.

Title of project

Health aspects of the disposal of human wastes into the marine environment.

Background and justification

In the Caribbean region, where the economies of many territories depend heavily on tourism, there is considerable potential for the importation and exchange of pathogenic agents.

There is little available epidemiological information and few statistics in the region to quantify the occurrence of disease due to infectious organisms in marine water. But the fact that past medical research has identified the existence and persistence of certain disease organisms in sea water - for example Vibrio cholerae and Salmonella - warrants the treatment and disposal of human wastes in a manner conducive

to the prevention of disease, to the maintenance of the aesthetics of the coastal environment, and to the mental well-being of man.

In the Caribbean where the discharges of heavy metals, halogenated hydrocarbons and PCB's in the marine environment are limited in frequency and magnitude, sewage that has been inadequately treated and discharged in the ocean is the principal threat to man's health.

Objectives

Short-term objectives

(a) Assessment of the existing sanitary quality of coastal marine water throughout the Caribbean region.

(b) The establishment of a data bank that may be used for follow-up action and future studies.

(c) The strengthening of the national institutions that would be participating in this programme.

Long-term objectives

(a) Reduction of health risks associated with bathing in marine water and with eating shellfish and other sea-food.

(b) The general improvement in public health.

COASTAL PROCESSES RELATED TO THE TRANSFER AND MIXING OF CONTAMINANTS

Two areas of interest were identified, based on considerations of size and geography.

The circulation of water masses was discussed, but without emphasizing any particular pollutant, the water masses being regarded as the agents of transport of the pollutants.

A project on the coastal zone was agreed upon. The term 'coastal zone' was understood to include estuaries, lagoons, bays and rivers, although it was agreed that every river has an estuary. Although it was recognized that any given study would only deal with a specific limited area, it was expected that several similar studies would be carried out in a large number of such areas within a regional framework.

A second project on medium-scale eddy circulation was also agreed upon. It was recognized that a lot was already known about the large-scale circulation, although further study was required.

Bearing in mind that in coastal regions the large-scale circulation gives rise to medium-scale eddies about which not very much is known, and given that most pollutants are discharged into the water over the continental shelf, it was felt that a project on these eddies was required.

Title of project

Investigation of the hydrological regime as it affects the transport and fate of pollutants in coastal lagoons and estuaries.

Background and justification

Coastal lagoons and estuaries constitute the transition between the fresh water and the marine environments. Both possess the most productive tropical ecosystems, and are the habitat, breeding grounds and nursery areas of a large number of species of fish and shellfish, many of which migrate from the one environment to the other.

Further, estuaries and coastal lagoons are very sensitive to changes caused by the activities of man, such as the modifications in the water discharge, land reclamation, dredging of inlets, as well as the introduction of industrial, agricultural and domestic pollutants and wastes. Therefore a knowledge of the hydrological regime is of fundamental importance to understanding the transport and renewal processes that take place in coastal lagoons and estuaries.

Objectives

Short-term objectives

(a) To assess the exchange rate of water, suspended matter and sediments between the different areas of the system, as well as across its boundaries.

(b) To study the main factors determining the flux of pollutants between the estuaries and the open sea.

(c) To promote standard methodology for investigations of the hydrological regimes of coastal lagoons and estuaries.

Long-term objectives

(a) To provide information on factors affecting the distribution, transport and fate of pollutants in coastal lagoons and estuaries.

(b) To determine the flux of pollutants between the estuaries and the open sea.

(c) To provide basic information for the rational use and management of the coastal environment.

Title of project

The effect of medium-scale eddies on the transfer and mixing of pollutants.

Background and justification

The main circulation pattern in the Caribbean region has been fairly well studied and the gross patterns are known. These studies have shown that medium-scale eddies are detached from the large-scale circulation and

appear to be trapped along coastal regions. Such eddies exist, for example, in the western and southwestern parts of the Caribbean as well as in the Gulf of Mexico.

The structure of these eddies, their persistence and renewal, and their possible trapping effect on, and transport of, pollutants is not known. The eddies border the coasts and could very well be confined by the coastal features and topography; they are also affected to some extent by conditions, such as precipitation. The eddies border several countries and the proposed studies will require international co-operation. A common methodology should be developed and equipment and personnel resources may have to be pooled.

Objectives

Short-term objectives

(a) To determine the persistence and the rate of renewal of the main eddies, and the time and space scales of these processes.

(b) To determine the generating mechanisms, the types of motion in the eddies and mixing conditions therein.

(c) To determine the variability of the eddies due to seasonal and climatic factors.

(d) To establish a common procedure and methodology for such types of studies.

Long-term objectives

(a) To contribute to a better knowledge of the general conditions and circulation in the Caribbean region, as related to pathways, distribution and dispersion of pollutants.

(b) To identify particularly critical areas and specific regional problems related to these eddies.

EFFECTS OF MARINE POLLUTION ON LIVING RESOURCES

As a basis for identifying the problems related to the possible effect of pollutants on living marine resources in the Caribbean region, information on present knowledge - particularly on fish and shellfish stocks - was exchanged, and it was concluded that proposals for projects were mainly governed by our limited knowledge of tropical ecosystems and the pollutants that affect them. The limited available resources were also borne in mind.

At first six possible projects were considered. From these three broader, more flexible projects were selected to take account of the priority problems of the countries in the region.

A project on the effects of pollutants on tropical ecosystems was accepted without major controversy.

A second project on regional baseline and monitoring studies of persistent chemicals in the Caribbean and Gulf of Mexico was also adopted. However, Dr Kullenberg expressed concern regarding the use of the term "monitoring". While agreeing on the need for data on the concentrations of persistent chemicals, he felt that only on the basis of a first assessment of the distribution and concentration of pollutants (baseline study) can it be decided whether monitoring is required, and, if so, a reasonable monitoring system should be designed. Experience from other parts of the world clearly shows the need for a baseline study that includes intercalibration exercises before monitoring is initiated.

A project on controlled experiments on the effect of pollutants on tropical marine organisms at the community level was discussed. This project gave rise to considerable controversy, in the light of the results of experiments such as CEPEX.* It was felt that such programmes are costly and the results are difficult to interpret. Some participants felt that this project could be incorporated in the first project mentioned above, as a means of understanding the actual state of tropical ecosystems in the area.

Eventually all three projects were approved.

Title of project

Effects of pollutants, especially those from domestic and industrial sewage, on tropical ecosystems of economic importance.

Background and justification

Changes of environmental variables and the introduction of certain substances into the marine waters can have serious adverse effects on the biota. Knowledge of effects of various pollutants on marine organisms and populations is, however, mainly restricted to the temperate areas. Taking into account that this knowledge of different environmental conditions cannot readily necessarily be easily applied to tropical ecosystems. Considering the scarcity of knowledge of the tropical areas, studies on the effects of pollutants on locally or regionally important ecosystems are essential.

Objectives

Short-term objectives

(a) To identify the critical pollutants threatening important tropical ecosystems, such as mangrove swamps, coral reefs, etc.

---

* CEPEX "involves trapping water and natural communities in large plastic enclosures (10m. in diameter by 30m. deep) and assessing the effects of added pollutants on marine ecosystems - the long-term effects influencing the stability of marine populations."

(b) To obtain baseline data on the nature and level of pollution in these important tropical ecosystems.

(c) Through bioassays and toxicity tests to determine lethal levels and sublethal effects of certain pollutants on locally or regionally important species.

(d) Through collaboration of institutes in a network to provide for exchange and intercomparison of results and methods.

Long-term objectives

To provide a better understanding of the effects of certain pollutants on marine organisms and their polulations and ecosystems through laboratory and field experiments, and through observations of long-term effects of potential pollutants and their transformation products. The project will ultimately enable countries to improve mechanisms for establishing water quality criteria.

Title of project

Baseline and monitoring studies of persistent chemicals in the Caribbean, Gulf of Mexico and adjacent regions.

Background and justification

The deleterious effects of certain persistent chemicals on marine organisms has been demonstrated. Unfortunately population pressures and agrarian economies of many Caribbean countries result in continued use of these materials which eventually find their way to the sea in large quantities. They are transported either absorbed on the suspended load (e.g. D.D.T. and its metabolites, PCB's, Mirex) or in the dissolved phase (e.g. Endrin, Aldrin and its hydrolytic product Dieldrin). Eventually these materials are incorporated in marine organisms - especially plankton, benthic and pelagic fauna and sea birds. A clear need for monitoring persistent chemicals exists. Specific chemicals should be chosen for monitoring on the basis of what can be learned about their regional production and use. The results of such a programme would be available to governmental and intergovernmental agencies for use in the management and regulation of such chemicals. As development in the Caribbean and northern South America (especially in the Amazon, Orinoco and Magdelena river drainage basins) increases inputs of these materials, the need for such regulation will increase.

Objectives

Short-term objectives

To establish a network of monitoring stations on a sound scientific basis. This network should include river stations, coastal stations, island stations and open-ocean stations (e.g. a station in the Guyana current, the eastern Caribbean, the western Caribbean, the straits of Yucatan, the eastern and western Gulf of Mexico and the straits of Florida).

Long-term objectives

(a) To develop a network of monitoring capabilities in the countries of the region to monitor levels of specific persistent chemicals in the dissolved and suspended load of nearshore and open-ocean waters as well as in commercial catches of marine organisms and specific sea-bird populations and their eggs (e.g. those on Las Islas de los Aves and La Isla de Aves).

(b) To make available the information obtained from this monitoring to both regional states and intergovernmental agencies for their use in recommending and establishing regulatory measures.

Title of project

Controlled experiments on the effects of pollutants on tropical marine organisms and ecological communities.

Background and justification

Recent bibliographies show that our knowledge about the lethal and sub-lethal effects of pollutants upon the marine environment is almost exclusively based upon investigations in temperate waters. Results from the Controlled Ecosystem Pollution Experiment (CEPEX)*, Saanich Inlet, Vancouver Island (Canada) prove that the inter-relationships of organisms and the pollutants and their pathways within the ecosystem constitute a far more difficult problem than can be assessed by laboratory assays, and it is certainly one for which there is a great need of scientific information. In view of the fast-increasing pollution of tropical waters and the limitations of laboratory investigations in the study of effects, a CEPEX type of experiment should be set up as soon as possible in a tropical site. The greater Caribbean region appears at present to be the most promising tropical area where a CEPEX-type experiment could be successfully carried out.

Objectives

Short-term objectives

(a) To assess the effects of added pollutants (including heat, hypo- and hyper-saline water) on natural populations of tropical marine organisms in controlled experimental ecosystems (i.e. in CEPEX-type enclosures).

(b) To actively involve, and hence train, students and scientists from the Caribbean and adjacent regions in the basic as well as more advanced chemical and biological investigations that comprise a CEPEX-type experiment in tropical waters.

---

* CEPEX - See footnote on page 20.

Long-term objectives

To provide an understanding of the effects of pollutants on the tropical marine environment so that long-term threats to this environment perceived through doubtful extrapolations of data from experiments in temperate waters could be properly assessed.

3.3 Training, education and mutual assistance

The Workshop, in proposing the above-mentioned projects, recognized that training, education and mutual assistance were the most important elements, together with the development of appropriate and standardized sampling and analytical methods for the region. However, to avoid repetition, they were not included in the objectives of each project description.

In the discussion it was repeatedly emphasized that (1) training and education should be carried out within the region, rather than at extra-regional institutions, in order to guarantee that the personnel involved be exposed to the problems and needs of the region, and (2) training and education be problem- and project-oriented. Mention was made of the need for field training, especially on board appropriate research vessels. Other specific needs mentioned were: basic training in techniques of monitoring temperature, dissolved oxygen, for example; training in sewage and industrial waste-water treatment processes; and basic training in marine ecology. It was noted that, in order to achieve the long-term objectives of the proposed projects, it would also be necessary to provide broad-based advanced education in marine sciences.

Among the specific opportunities for training and education, the following were mentioned: the University of Puerto Rico School of Public Health, the facilities of the Universidad Nacional Autónoma de Mexico, various institutions in Venezuela and Jamaica, the Bellairs Research Institute of McGill University in Barbados, and the University of Miami. Reference was again made to the proposed IMCO/UNEP course on oil pollution. Concern was expressed regarding the status of the UNDP-supported programme at the Universidad Nacional Autónoma de Mexico, which has in the past proved to be so fruitful.

It was pointed out that, in assessing needs specific to marine pollution problems in the region, particular attention should be paid to the report of the First ad hoc TEMA meeting (doc. IOC/TEMA-CARIB-I/3), Mexico City, Mexico, 10-12 April 1975.

The Workshop called on the governments of the region that were interested to participate in the proposed pilot projects should they eventually be approved by them, to identify their training and technical assistance needs relevent to the proposed projects and to communicate these to the sponsoring agencies of the Workshop.

3.4 Data handling

Existing data handling systems were generally considered to be adequate for the needs of the region. Mention was made of World Oceanographic Data Centres A and B and of the Centro Colombiano de Datos Oceanográficos. Mention was also made of the Epidemiology Data Centre of the World Health Organization. In this respect, it was also noted that pollution data might not be adequately handled by oceanographic data centres.

3.5 Information retrieval

Although it was generally recognized that several information retrieval systems existed, the general feeling was that the greatest need was for the strengthening of library and information facilities at the actual institutions where research was being carried out. A strong case was made for the usefulness of abstracts and content listings. Among those mentioned were: the FAO-UNESCO Marine Science Contents Table, Pollution Abstracts, Deep-Sea Research and Oceanographic Abstracts, Current Contents, Aquatic Science and Fishery Abstracts, and the US Environmental Protection Agency Newsletter. Special mention was made of the Guide to International Marine Environmental Services which was distributed to participants in the Workshop. Among the institutions that might possibly prove to be useful in this respect, mention was made of the Marine Pollution Documentation Centre of the UK Marine Biological Association in Plymouth, England, and of the facilities at the Universidad de Oriente, Instituto Oceanográfico in Cumaná, Venezuela. It was also pointed out that IOCARIBE would retain a consultant in 1977 to determine the needs for documentation in the region with respect to the activities of this body.

The Workshop, in a general discussion of items 3.3, 3.4 and 3.5, placed special emphasis on the need to reinforce existing institutions, and on the importance of avoiding the establishment of costly new institutions towards which funds could be diverted and to which regional experts might migrate, to the detriment of the developing countries of the region.

4. Adoption of the report

The Workshop adopted the summary report of its deliberations. However, it was requested that the basic texts of the invited lectures and three information documents be included as annexes. Since the wish was also expressed that the Workshop report be speedily published, which would not be possible with several large annexes, the sponsoring organizations agreed to look into the possibility of presenting these annexes in the form of a supplement which could be distributed later than the report itself.

5. Closure of the Workshop

In closing the Workshop the Chairman, Professor Julian Kenny, thanked the participants for their co-operation and active participation. He expressed the hope that the Workshop's proposals would be speedily put before the national authorities and be expeditiously implemented.

Mr Raymond Griffiths, on behalf of the sponsoring organizations, thanked the Chairman for his conduct of the Workshop, and thanked the Secretary-General of the Trinidad and Tobago National Commission for Unesco for providing the local services.

The Workshop was closed at 16.00 hrs., 17 December 1976.

ANNEX I

AGENDA

1. Opening of Workshop: Welcoming addresses; installation of Chairman; election of Rapporteur; keynote speech by Dr Keckes.

2. Invited lectures and discussion on:

   (a) Regional oceanography as it relates to present and future pollution problems and living resources.

   (b) Pollution research and monitoring for heavy metals.

   (c) Pollution research and monitoring for hydrocarbons.

   (d) Pollution research and monitoring for halogenated hydrocarbons and pesticides.

   (e) Pollutant transfer and transport in the sea.

   (f) Health aspects of coastal water pollution.

   (g) Political aspects of marine pollution and development of political awareness of marine pollution problems.

3. Plenary debates on:

   (a) Regional marine pollution problems and priorities for research and monitoring.

   (b) Proposals for regional research and monitoring programmes, including research needs in relation to parameters to be monitored.

   (c) Specific training and technical assistance needs and opportunities in relation to the proposed programme.

   (d) Data handling procedures.

   (e) Information sources and their retrieval.

4. Adoption of the report.

5. Closure of the Workshop.

ANNEX II - ANEXO II

LIST OF PARTICIPANTS - LISTA DE PARTICIPANTES

NAME - NOMBRE	FULL POSTAL ADDRESS - DIRECCION
REGIONAL EXPERTS - EXPERTOS DE LA REGION	
Arthur E. ARCHER	Environmental Engineering Services Ministry of Health & National Insurance Jemmotts Lane Bridgetown, Barbados
Donald K. ATWOOD	NOAA/AOML 15 Rickenbacker Causeway Miami, Florida 33149, USA
Alfonso V. BOTELLO	Centro de Ciencias del Mar y Limnología Universidad Nacional Autónoma de Mexico Apartado Postal 70-305 Mexico 20, D.F., Mexico
Gilberto CINTRON-MOLERO	Programa Oceanográfico Departamento de Recursos Naturales P.O. Box 5887 Punta de Tierra, Puerto Rico
Jorge CORREDOR	Carrera 7A No.87-81 Bogota, D.E. Colombia
Luis E. GARCIA M.	0a Av. 3-10 Zona 10 Ciudad de Guatemala Guatemala
Julian S. KENNY (Workshop Chairman)	Department of Biological Sciences University of the West Indies St. Augustine, Trinidad and Tobago
Bogdan KWIECINSKI	Laboratorio de Biologia Marina Facultad de Ciencias Estafeta Universitaria Universidad de Panama Republica de Panama
G. Winston MILLER	Fisheries Laboratory P.O. Box 148 Belize City Belize C.A.
Manual MURILLO	Vice-rector de Investigacion Universidad de Costa Rica San Jose, Costa Rica

Hernan PEREZ NIETO — Instituto de Tecnologia y Ciencias Marinas (INTECMAR)
Universidad Simon Bolivar
Apartado 5354, Caracas, Venezuela

Quirino B. RICHARDSON — Health Service
Zaquito
Curaçao, Netherlands Antilles

Rafael SANTIAGO — 7ª Ave, 14-57 Zona 13
Cuidad de Guatemala
Guatemala

Rafael STEER — Departamento Nacional de Plantacion
Division Recursos Naturales
Edificio Seguros Colombia
Bogota, Colombia

Barry A. WADE — Zoology Department
University of the West Indies
Kingston 7, Jamaica

INVITED LECTURERS AND AUTHORS - ORADORES Y AUTORES INVITADOS

Donald K. ATWOOD — NOAA/AOML
15 Rickenbacker Causeway
Miami, Florida 33149, USA

Lennox BALLAH — Ministry of External Affairs
Port of Spain
Trinidad and Tobago

Alfonso V. BOTELLO — Centro de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de Mexico
Apartado Postal 70-305
Mexico 20, D.F., Mexico

Eugene F. CORCORAN — Rosenstiel School of Marine & Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, Florida 33149, USA

Ingvar EMILSSON — Centro de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de Mexico
Apartado Postal 70-305
Mexico 20, D.F., Mexico

Gunnar KULLENBERG — University of Copenhagen
Institute of Physical Oceanography
Haraldsgade 6
2200 Copenhagen, Denmark

Enrique F. MANDELLI	Centro de Ciencias del Mar y Limnología Universidad Nacional Autonoma de Mexico Apartado Postal 70-305 Mexico 20, D.F., Mexico
Jean-Marie MARTIN	Laboratoire de Geologie Ecole Normale Superieure 46 rue d'Ulm 75230 Paris - Cedex 05, France
Eric MOOD	Department of Epidemiology & Public Health Yale University School of Medicine 60 College Street New Haven, Conn.06510, USA

OBSERVERS FROM INTERNATIONAL ORGANIZATIONS AND U.N. MEMBER STATES
OBSERVADORES DE LAS ORGANIZACIONES INTERNACIONALES Y DE LOS ESTADOS MIEMBROS DE LA O.N.U.

UNITED NATIONS ENVIRONMENT PROGRAMME
PROGRAMA DE LAS NACIONES UNIDAS PARA EL MEDIO AMBIENTE

Trevor BOOTLE	Presidente Masaryk 29 Mexico 5, D.F., Mexico

INTERGOVERNMENTAL MARITIME CONSULTATIVE ORGANIZATION
ORGANIZACION CONSULTIVA MARITIMA INTERGUBERNAMENTAL

Marian FILA	101-104 Piccadilly London W1V OAF, U.K.

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA EDUCACION, LA CIENCIA Y LA CULTURA

Robert R. LANKFORD	Centro de Ciencias del Mar y Limnología Universidad Nacional Autónoma de Mexico Apartado Postal 70-305 Mexico 20 D.F., Mexico

UNITED NATIONS DEVELOPMENT PROGRAMME
PROGRAMA DE LAS NACIONES UNIDAS PARA EL DESARROLLO

Cruz A. MATOS	Box 812 Port of Spain Trinidad and Tobago

GULF AND CARIBBEAN FISHERIES INSTITUTE

G. Winston MILLER	Fisheries Laboratory P.O. Box 148 Belize City Belize C.A.

WESTERN CENTRAL ATLANTIC FISHERY COMMISSION
COMISION DE PESCA PARA EL ATLANTICO CENTRO-OCCIDENTAL

Heiner C.F. NAEVE
Fishery Resources and Environment Division
Department of Fisheries
Food & Agriculture Organization
Via delle Terme di Caracalla
00100 Rome, Italy

INTERNATIONAL ATOMIC ENERGY AGENCY
ORGANISMO INTERNACIONAL DE ENERGIA ATOMICA

Charles OSTERBERG
IAEA International Laboratory of Marine Radioactivity
Principality of Monaco

ECONOMIC COMMISSION FOR LATIN AMERICA (OF THE U.N.)
COMISION ECONOMICA PARA AMERICA LATINA (DE LAS NN.UU.)

Jean-Claude PANIS
P.O. Box 1113
Port of Spain
Trinidad and Tobago

CARIBBEAN CONSERVATION ASSOCIATION

Jill SHEPPARD
Savannah Lodge
The Garrison
St. Michael, Barbados

IOC REGIONAL ASSOCIATION FOR THE CARIBBEAN AND ADJACENT REGIONS
ASOCIACION DE LA COI PARA EL CARIBE Y REGIONES ADYACENTES

Dirk G. TROOST
c/o UNDP
P.O. Box 812
Port of Spain
Trinidad and Tobago

WORLD HEALTH ORGANIZATION
ORGANIZACION MUNDIAL DE LA SALUD

Barry W. WHALLEY
PAHO/WHO
P.O. Box 898
Port of Spain
Trinidad and Tobago

Haydel A. LOURENS
Legal Department of the Island Territory of Curaçao
Concordia Street 27
Curaçao, Netherlands Antilles

Fred A. PETERKIN
Co-ordinator - IDRC Fisheries Research Project
P.O. Box 236
Georgetown, Guyana

LOCAL OBSERVERS - OBSERVADORES LOCALES

Eddison BAPTISTE	Trinidad & Tobago Field Naturalists Club Lot 11 St. Lucien Road Diego Martin Trinidad and Tobago
Ian LAMBIE	64 Roberts Street Woodbrook Port of Spain Trinidad and Tobago
Hazel MUTUNHU	Department of Biological Sciences University of the West Indies St. Augustine Trinidad and Tobago
Prem NANDLAL	269 Gopaul Circular Drive Marabella Trinidad and Tobago
Krzysztof RAJKOWSKI	Department of Biological Sciences University of the West Indies St. Augustine Trinidad and Tobago
Manniram REMBISSOON	Ministry of External Affairs c/o "Knowsley" 1 Queens Park West Port of Spain Trinidad and Tobago
David ROOKS	Trinidad & Tobago Field Naturalists Club c/o Elegant Products Ltd. 90 Eastern Main Road Laventille Trinidad and Tobago

WORKSHOP SECRETARIAT - SECRETARIADO DE LA REUNION

Jorge CORREDOR (Rapporteur)	Carrera 7A no.87-81 Bogota, D.E. Colombia
Raymond C. GRIFFITHS	Intergovernmental Oceanographic Commission Unesco 75700 Paris, France
Stjepan KECKES	United Nations Environment Programme Geneva Liaison Office Palais des Nations Geneva, Switzerland

Julian S. KENNY
(Workshop Chairman)

Department of Biological Sciences
University of the West Indies
St. Augustine
Trinidad and Tobago

Axel WENBLAD

Fishery Resources and Environment Division
Department of Fisheries
Food and Agriculture Organization
Via delle Terme di Caracalla
00100 Rome, Italy