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Summary report of the TECAM seminar on environmental impact assessment of aquaculture farms in the Mediterranean

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Presentation of the workshop

Mr. Miguel Valls, IAMZ director, began by welcoming participants. He gave a brief introduction of CIHEAM and its origin and explained its objectives as a centre of international cooperation between Mediterranean countries in the field of agriculture and natural resources and spoke of the various short and long-duration training programmes organised by IAMZ.

Mr. Valls commented on how the development of aquaculture in the Mediterranean was a relatively young activity and spoke of the lack of specific legislation, especially on aspects such as the environmental impact of aquaculture farms, their incompatibility or friction with other coastal zone activities, etc. He trusted that the participants would gain deeper knowledge in the field and encouraged them to discuss the wide range of topics that were to be addressed during the seminar.

He then invited Mario Pedini to take the floor as representative of the Fisheries Resources and Environment Division of the FAO. Dr. Pedini, after briefly introducing FAO activities and its nexus of union with CIHEAM, made a particular emphasis on the Code of Conduct for Responsible Fisheries drawn up by FAO and its article 9 where special mention is made of the need to bring aquaculture into harmony with the environment.

Finally Dr. Adolfo Uriarte, representative of the AZTI Foundation and scientific coordinator of the workshop, presented the programme. He considered that the guest speakers and participants in the seminar were most appropriate and hoped that there would be abundant debate and discussion. Like Mr. Valls, he considered that aquaculture activity needed to be regulated.

Session 1: Introduction

Development of aquaculture and the environment. *H. Rosenthal (Univ. Kiel, Germany)*

Dr. Rosenthal made a general description of aquaculture activity; its production levels, the need for regulations, interaction of aquaculture with other aspects of the environment, different cultures and existing farmed species, etc.

He spoke of the various impacts of aquaculture activity such as the use of antibiotics, how it affects benthos, eutrophication problems, disease transmission, escape of fish that could mix with allochthonous species, problems with the geographic location of the farms, etc. He emphasised the need for norms to regulate a good production practice and gave the case of Norway as an example.

He finally spoke of the future diversification of farmed species, the minimisation of waste and of using fishmeal as feed, polyculture, the possibility of applying aspects of fish biology to cure human diseases and the decrease in the output of nutrients, etc.

Perspective of coastal management. *H. Rosenthal (Univ. Kiel, Germany)*

Dr. Rosenthal talked of aquaculture as an activity with the same rights as any other carried out in

the coastal zone. However, it interferes with other uses and environment-related aspects, therefore it needs an integrated management from all points of view.

He listed both positive and negative aspects of aquaculture production on the environment, placing special emphasis on the introduction of allochthonous species. He finally pointed out the need to gain deeper knowledge on the environmental and economic impacts of aquaculture activity in order to propose an integrated management model that would harmonise what was possible (science) with what was desirable (social science).

A perspective of environmental management for aquaculture. *C. Alvarez (IPAE, Spain)*

Like Dr. Rosenthal, Dr. Alvarez mentioned the negative aspects of aquaculture such as waste, chemical pollutants, introduction of species, etc. She also talked of the positive aspects of aquaculture activity such as the revitalisation of biotopes, its needs to maintain the quality of waters, etc., and its interrelationship with other uses in the marine environment.

She then went on to speak of the large number of legal texts regulating various aspects of influence or in relation to aquaculture exclusively in the Mediterranean (Plan of Action of the Mediterranean, signed in Barcelona on 10 June 1995, European Directives 79/409 and 92/43, Law on EIA, Proposal of Directive) in relation to the evaluation of the effects of plans and programmes, etc.

She finally pointed out that there was no normative that explicitly regulated aquaculture activity in the Mediterranean.

Discussion: When asked about the deadlines of the habitat directive concerning specially protected areas of Mediterranean importance and the Network Natura 2000, Dr. Cristina Álvarez explained that there was a delay of four years, the list was not yet in force and the Administration and the legislators were very slow.

A participant doubted that all countries would be able to comply with the same normative, as there were countries with very different legislations and degrees of scientific development. He was told that the normative applies to minimum thresholds that all countries could comply with.

Session 2: Environmental framework in relation to aquaculture

Principles and modelling of hydrography and hydrology. *F. Rivero (UPC, Spain)*

A very comprehensive lecture was given on the oceanographic features of the Mediterranean, the forces governing the oceanic and coastal circulations, tides, wave types and source and finally the physical phenomena that explain the dispersal of pollutants (advection, diffusion, buoyancy, chemical properties, etc.).

As a continuation, he explained how to integrate all the aspects mentioned previously to build simulation models for the dispersal of pollutants from various sources, effluents, submarine outlets, aquaculture farms, etc.

Discussion: Many participants voiced their concerns about the impact of wave movement on the cages and the depth below which the waves would not break on the structures. Dr. Rivero clarified some concepts for example that the wave period was just as, if not more important than the wave height. The limit of shallow waters was not fixed, but depended on the characteristics of the zone itself and on the incident swell.

Ecological effects of aquaculture on the Mediterranean. *J. Karakassis (IMBC, Greece)*

Dr. Karakassis began his lecture by broadly describing the physico-chemical, ecological and geomorphologic characteristics of the Mediterranean.

He later referred to the main impact of aquaculture, that is the enrichment of the sediment and waters in organic matter and nutrients which gives rise to the alterations of the natural physico-chemical properties of the water and the sediment and the benthic communities.

Here Dr. Karakassis revised the different existing models: empirical models, balance of masses, dispersal models, ecological models, etc. All these models make a series of suppositions including analytical boundaries (without changes in bathymetry, without later depositions, uniform speed and direction of currents, sedimentation speed of uniform particles, etc.).

He also contributed interesting data showing that the anthropogenic supply of nutrients into the sea is 400 times greater than that supplied by farms. 300 years of farming would be necessary to increase dissolved phosphorus by 1% in the Mediterranean supposing that there was no renewal of waters. However the problems are presented on a smaller scale, at a local or regional level.

Discussion: Discussion was held about the evolution over time of the sediment once a sea farm has been abandoned. Participants likewise discussed whether it was appropriate or not to farm in the high seas, *"site selection",* etc.

Session 3: Production aspects related to the environment

Nutrition and feeding. *A. Dosdat (IFREMER, France)*

First of all an introduction was given on the feeding behaviour and energy yield and use that a fish makes of the feed given to it according to age, size, environment, etc. Dr. Dosdat proposed substituting protein-rich diets for diets rich in carbohydrates, that were energetically more profitable.

Likewise, a more or less quantitative assessment was made of the different waste produced (faeces, excreta, etc.) and different quantification methods were provided.

Finally the speaker pointed out a series of guidelines for correct feeding and as a conclusion pointed out that it was necessary to study further the feeding habits of the species so as to minimise impacts and maximise energy yield of the farmed fish.

Discussion: Some producer participants present pointed out how weak the link was between scientific and aquaculture research and the real situation of the farms. They considered that technical aspects were discussed that are impossible for the aquaculturist to implement.

Dr. Rosenthal talked at length on the need to understand more about fish behaviour in order to optimise the yield of fish farms and to protect the environment.

Health management. Impact of the introduction of pathogens. *G. Blanc (SVM, France)*

Prof. Blanc began by analysing the diversity of sources of introduced pathogens and how difficult it was to develop a method for their detection. He pointed out the narrow relationship that existed between water quality (contamination) and the presence of pathogens and stress derived from these conditions for the development of a disease in the cultivated species.

He also pointed out the need to make more detailed epidemiological studies of fish, to determine whether the drugs administered to fish were really effective. He pointed out that there were biological indicators for fish that warn of stress in that species.

He advocated DNA sequencing to make a better identification of pathogens. Techniques that two years previous had been considered tremendously sophisticated should become routine procedures in the near future.

He gave the example of the influence of the most devastating pathogens that occurred in Brittany, France, in the mussel and oyster farms. Particular species suffered severe mortalities and other species have had to be farmed instead.

Finally he mentioned aquaculture activity as a source of pathogens, and also made a special emphasis on escapees, contact with pollutants, transport, lack of good husbandry and sanitary precaution measures, etc.

Discussion: A proposal was made to take advantage of the Norwegian experience with pathogens, the introduction of new fish farms exponentially increasing danger, and also to avoid the transport of individuals and to fine companies that did not follow appropriate handling and transport practices.

A participant from Morocco mentioned problems in oyster production in the Bay of Arcachon. These oysters died en masse, as a consequence of exposure to organic compounds present in the antifoulant paints of the boats in the Bay.

Interactions with wildlife. *M. Beveridge (Univ. Stirling, UK)*

M. Beveridge made a general revision of the problems that arose as a result of the interaction of aquaculture activity with natural resources. Among these problems he mentioned the following changes in uses of habitat, introduction of allochthonous species, organic enrichment of waters as a consequence of feeding, changes in the biodiversity of the habitat, introduction of diseases, changes in the behaviour of particular species such as birds that feed from the cages, etc.

Later, he put forward a number of solutions for different problems, such as the birds, waste, escapees, etc. In particular he pointed out the importance of this latter aspect, showing, through different examples, what had happened in real cases.

Discussion: In reply to the question on how many species swam around the cages searching for food, etc., Dr. Beveridge admitted that this aspect had not been greatly studied and that reliable data was not available although experience estimated the pressure was at about 10 and 30%.

Genetic manipulation studies were suggested in order to determine whether there really was a genetic patrimony of species as a consequence of escapes, or manipulation in order to obtain new species resistant to certain diseases or interesting for commercial purposes.

Session 4: Assessment and monitoring

Selection of sites for sea farms. *A. Uriarte (AZTI, Spain)*

The lecture began with a brief introduction of concepts such as sustainability and integrated management of the coastal zone. All uses made in relation with the sea environment, including aquaculture, have the same right to subsist.

He listed the different conflicts of aquaculture with other uses made of the sea environment (sailing, harbour activities, fishing, conservation of zones, industrial activities and tourism, etc.).

Excessive feeding and excreta are the main causes of impact; biodiversity and benthic fauna being the two environmental elements most affected.

Among the difficulties for a good site selection is the lack of information on aspects such as the quality and quantity of pollutants generated, the ratios of amount of feed and biomass, types of species, water quality, possible effects of diseases, parasites, etc. He pointed out basic data needed for a choice of site: temperature and salinity, hydrodynamics, swell, sediment granulometry, distance from nature reserves, etc.

As a conclusion he pointed out the following basic norms: (i) gather all available information on possible restrictions or regulations for the installation of fish farms; (ii) the choice of zones should be appropriate for the existing technology or the correct technology should be found for the zones selected; (iii) speak with other investors on the distance from other farms; (iv) limit the minimum lease space; (v) consult the users of possible sites. Avoid areas of landscape or of natural interest; and (vi) adopt measures to minimise impacts.

Discussion: It was pointed out that the information on coastal zones likely to be used as aquaculture sites should be provided by the administration. Furthermore, there is a need to characterise the contamination that existed before the installation of cages in order to prevent any blame being placed on the cages for pollution that already existed.

A producer attendant disagreed with Dr. Uriarte stating that in reality these guidelines are very strict and if they were followed there would be no aquaculture farms. He commented that in his practical experience he was only given two sites to chose from. He was surprised that the norms were so exhaustive, even the waste fuel from the boats had to be controlled.

Methodological approaches for the study and monitoring of environmental impact of aquaculture. *H. Rosenthal (Univ. Kiel, Germany)*

An initial introduction was made on a series of questions such as: Why monitor? How to monitor? What should be monitored? How should one monitor? Who should monitor? How much monitoring is enough?

Different objectives arise according to whether the scale is international, national, regional or local. In generic terms, the main principles of monitoring are to become acquainted with the ecological consequences of aquaculture activity, design methods and calculations for the carrying capacity, establish criteria or standards for effluents, evaluate the holding capacity of the waters according to the size of the farm and the ecological sensitivity of the zone, etc.

Among the different objectives for the EIA in aquaculture established by GESAMP (Group of Experts on the Scientific Aspects of Marine Environmental Protection) are the following: (i) identify the positive and negative impacts; (ii) establish attenuation measures; (iii) identify residual impacts that can be neither corrected nor attenuated; (iv) develop strategies to monitor the impacts; and (v) aid site selection.

Among the different aspects to be monitored are the following: (i) production level; (ii) feeding efficiency; (iii) growth; (iv) zoning of areas to determine uses; (v) abundance of species; and (vi) structure of communities through multivariate techniques.

Monitoring. *T. Telfer (Univ. Stirling, UK)*

Dr. Telfer introduced his lecture by stating that there was no definitive method for monitoring and that the scientific world was more or less familiar with the international scientific baseline information.

Difference between pollutants derived from the metabolism of cultivated species and chemical pollutants derived from products used in farming, such as, antifoulants, antibiotics, pesticides, etc.

Monitoring fulfils its mission when it facilitates the establishment of management objectives: (i) the determination of acceptable areas or otherwise for the installation of aquaculture farms; and (ii) establishment of environmental quality objectives or standards.

Among the reasons presented for monitoring were the following: (i) establishment of a legal regulation; (ii) farm management (optimisation of resources); (iii) human health; and (iv) research (identification of impacts, model validation, development of methods, etc.).

Another important aspect of monitoring is its relationship with feedback processes in EIA. Monitoring ensures that the predictions made in EIA adjust to the reality of the impact. Likewise, the interest of monitoring was pointed out for the validation of the different models that are currently being used in aquaculture (dispersal of contaminants, etc.).

Dr. Telfer listed different types of pollutants: soluble, particulate, etc., and the effect that they have on the environment, changes in the granulometry composition of the sediment, changes in benthic communities, etc. Finally, he listed a series of considerations to be made when designing a monitoring plan (frequency, repetitions, position of the monitoring stations, sampling and analysis method, etc.)

and makes a presentation of the most commonly used sampling methods and of the most interesting analysis and interpretation techniques (bioindicators, principal components analysis, etc.).

Discussion: The interest of the monitoring programmes was underlined, not only from the environmental point of view but also from the point of view of farming, since the waste produced from the farm can be harmful to the farm itself. The case of the North of Europe is described. Their legislation contemplates aquaculture waste, and hence monitoring is carried out and those who pollute pay. This money is used to finance the monitoring.

An important discussion took place on *who should pay for this type of monitoring*, the producer or the government?

An Italian participant referred to the very high cost of monitoring programmes and stated that in Italy there is no regulation on this issue. To this effect he does not understand why producers should bear the cost of the monitoring when it is the government that should do so.

A Greek participant also considered that it was not the producers who should pay for this work, since the reality of their daily life (market competition and reduction of production cost) is far from the scientific aspects discussed in this workshop. He regretted that there were no types of reference levels or standards that consider the quality of the environment.

Another participant from Greece considered that the different impacts took place on different time scales, therefore the monitoring would be different for each. He considered that given that in the short term it is the producer who is affected by the impact of his farm, it should be he who covers the costs. In the long term, it should be the national authorities that establish standards and reference levels.

A participant from the UK pointed out that normally the promoter was not the owner of a fish farm, but that they were normally leased. On the other hand, he mentioned that in USA there is a normative related to water quality that would soon be applied to the coastal zone, integrating everything, which will have great consequences.

A French participant spoke of the law in France that accepts that the producer can carry out the monitoring and the results should later be presented to the competent authority.

Another participant from the UK commented that in Scotland it is the regulator who should carry out the monitoring and hires institutes and specialist bodies to do so. The fish farmers, for their part should also hire these bodies because they do not trust the results that the legislative body establishes on the basis of its own monitoring.

A participant from Germany was of the opinion that it was necessary to determine the level of monitoring and the factors to consider.

Methodological approaches for the monitoring of Mediterranean species. *A. Belmonte (Murcia, Spain)*

Dr. Belmonte placed great emphasis on the preliminary studies of a zone before setting up a fish farm with the objective of being able to carry out a better evaluation of the impacts.

For these studies it is first of all necessary to review the bibliography and take data *in situ* establishing control stations. Likewise he pointed out the utility of modelling contaminant effluents from fish farms.

As an example he put forward two case studies carried out on Cape Tiñoso (Murcia) where blue-fin tuna is cultivated.

Discussion: Mr. Belmonte was asked numerous questions about his practical experience: farming density, number of individuals, type and abundance of wild species that approach the cages. He was also asked about details of the monitoring data, how long the current meter has to be anchored, the time necessary for cataloguing species, time used for sampling sediment.

The discussion then focused on the different and high feed conversion indices obtained for tuna and particularly if the knowledge gained on one species can be extrapolated to another. In reference to this question, Mr. Belmonte explained that the index calculated for the farm that he studies might be around 45:1, as the producers do not control that expense too much since their major concern is to fatten up the tuna as much as possible. On the other hand Dr. Beveridge gave example of feed indices obtained for tuna in Australia: FCI of 10:1 obtained from feeding with whole fish. He explained that rejected feed does not form part of the sediment because as it is whole, it is consumed by species that live on the sediment such as wild fish, crabs and other detritivores.

In turn, the participants also commented at what depth, within a given draught, cages would affect benthos.

On the other hand, Mr. Belmonte was asked to speak of his experience in the monitoring plan that has carried out since 96/97. He explained that after 4 years problems start to arise with benthic communities and sediments. He considers that a lot of feed is wasted. He also explained how his monitoring techniques have improved. Water quality is no longer measured. Instead benthic communities, organic matter and granulometry are concentrated on.

General discussion on survey and monitoring

Dr. Mario Pedini (FAO) opened the discussion session, commenting on the lack of survey and monitoring studies in the Mediterranean, which implies a certain level of confusion. In this sense, he pointed out the interest of taking advantage of the experience acquired by colleagues from the North of Europe in spite of the fact that their aquaculture is not the same.

He defends reaching an honest compromise between the need to protect resources and the right to exploit them. He considers that in order for sustainable development to be reached, there should be a consensus between the Administration, the private sector and the scientific community. Among the lines of work for the future is the integrated management of the coast, to clarify work methodologies, identify lacks in EIA and establish quality standards, etc.

Dr. Blanc takes up the debate pointing out that strict regulations can contribute to the commercial framework of the end product, as consumers do not buy anything that does not have a given quality. However, he estimated that legislation should also evolve with science.

Regarding who pays, he stated that in France the fish farmer invests and pays in order to obtain a permit to farm. The producer pays for the monitoring the amount depending on the monitoring level required. Only the factors that can most affect production and in accordance with the production capacity.

As regards standards, the FAO representative took the floor to comment that there are similar typologies in different coastal zones. In these cases we can see the most important factors deriving from the monitoring work. Finally he pointed out that USA have designed standards for the Atlantic.

A producer appealed to the scientific community to be more concrete and to be more coherent with realities of the production sector.

Several lecturers replied by pointing out the existence of directives for monitoring drawn up by ICES. To this respect, they proposed to work on a consensus document gathering all this information, to talk at length on the issue of standards and to have some recommendations established.

Session 5: Practical experience

North of Europe. *T. Telfer (Univ. Stirling, UK)*

Dr. Telfer focused his lecture on the practical experience in Atlantic salmon, trout, mussels and oysters in the north of Europe.

He began by describing the experience in Norway, the LENKA project. This is a plan of coastal management that determines the sites where fish farming can be practised calculating the holding capacity of each zone. They use the MOM system (Modelling on-growing fish farms monitoring).

Later, comments were made of the experiences of Atlantic salmon farming in Scotland and the legal structure of planning for setting up fish farms (permit requirement, determination of the need to carry out an EIA or a EsIA, establishment of guides, etc. Some of the monitoring techniques used in Scotland, video and photo surveillance, sampling designs, multivariate analysis, etc., were presented.

The government has developed a handbook of quality standards for the release of certain contaminants into the marine environment. This handbook is constantly being revised. The effluents should be hydrographically characterised, using the establishment of base levels and a correct monitoring.

Finally the following areas for future development were pointed out: integrated management of the coastal zone, determination of the destination of waste generated, development of precise and validated models and obtaining a deeper knowledge of its utility.

Discussion: Regarding the monitoring cost for the producers, Dr. Telfer estimated that at least in Scotland the bureaucracy is more expensive than the work, pointing out that it may account for about 2% of the farmers' turnover all year. Likewise he envisaged a simplification of the EIA process and authorisation for the producers due to a strong administrative reordering of the government of Scotland.

France. *A. Dosdat (IFREMER, France)*

The lecturer started by explaining how French aquaculture is dominated by oyster and mussel culture. He also cited sea bass and sea bream farming in the North of France. He then went on to analyse the EIA process in France, very long (more than a year) and very bureaucratic. It is tremendously complicated and the principles of precaution, prevention and the polluter pays are followed, as well as transparency towards the general public.

There is a certain global management of the shellfish resource. This establishes zones of the different coastal areas indicating whether or not they are appropriate for the installation of a shellfish farm. However, he also pointed out that this type of work for finfish is needed.

He indicated that IFREMER was the top responsible body in monitoring the quality of the marine environment in France. He listed a series of problems or shortfalls, such as the lack of knowledge to model a system's holding capacity, thresholds above which there is an impact, a formula that relates to the concentration of a contaminant with the impact on biocenosis, lack of real knowledge about the faeces and waste, lack of knowledge on the genetic ailments of some species, ecotoxicology, etc.

Discussion: questions were raised on how to evaluate the holding capacity of an environment and more explanations about the zoning carried out for mollusc farming in France were made.

Spain. Fish farmers experiences. *F. Torrent (Aguaviva, Spain)*

He pointed out the very rapid development of aquaculture in Spain. After giving a historical review of the aquaculture sector in Spain, he analysed the cultivation of different species that are marketed in the country. Thereafter, he expressed his concern about some of the problems for development that the sector encounters in Spain. He regretted that this activity is seen as a polluting activity by the general public and feels that the scientific community is not taking a coherent approach .

Regarding EIA, he recalled that management of aquaculture farms is rapidly changing and commented that most impact studies are not based on how a farm will be managed in the future. In relation with the monitoring programmes, he estimated that on occasions the variables taken into account have nothing to do with the activity. One example is the control of bacteria from human faeces.

He proposed the following tools for good management: (i) appropriate choice of site; (ii) farm management (feeding, etc.); (iii) control of disease through an appropriate prophylactic and preventive treatments of species; and (iv) planning of coastal resources.

Mr. Torrent's lecture drew the following conclusions: (i) the good future of aquaculture depends on the conservation of the environment; (ii) there are management tools that can be applied; (iii) environmental law does not include aquaculture; (iv) aquaculture activity is so recent that the concessions for new farms are granted on a temporary basis and precariously; and (v) aquaculture can be considered as a very important strategic activity for the conservation of a given coastal species.

Discussion: Regarding the impact that farms may have on the environment, it was pointed out to Mr. Torrent that the farm rotation between different sites imply that the farmers recognise that the activity generates an impact on the environment and on its own installations. He answered that the administration does not know the impact of this activity and as a consequence obliges measurements to be made that have nothing to do with the impact caused by aquaculture. It was pointed out that the Administration cannot regulate aquaculture properly if all parties do not become involved in the process.

Greece. *S. Klaoudatos (NCMR, Greece)*

Dr. Klaoudatos began his lecture by giving a general background of aquaculture in Greece, making reference to the cultivated species, systems and production areas. He continued with an analysis of legal, planning and management frame of the sector, and explained the role of the Administration in the granting of licences.

He finished by presenting an overview of current practice for site selection and monitoring of cage units as well as the existing mechanisms to control environmental impact. He concluded by pointing out some future tasks to be carried out: (i) demonstrate the sustainability of the sector; (ii) increase knowledge; (iii) encourage meetings, congresses, seminars on aquaculture; (iv) determine the methodology of the impact studies in order to have comparable data; and (v) look for impact indicators.

Participants' contributions

A. Farrugia (NAC, Malta)

He began his lecture by explaining the geomorphology of the Maltese coast, the fundamental importance of tourism and the great development that marine fish farming has experienced in the last years in Malta, which is under the framework of a development plan. All this has given rise to the need to protect the small coast that this Island estate has. It is noted that after an evaluation survey, 5 areas/places have been established for cage farming activities. As for Environmental Impact Studies it is the National Centre of Aquaculture that is the responsible body for the monitoring of farms. The Centre analyses the water and sediments under the cages.

H. Deniz and S. Polatsu (Turkey)

This presentation started with a description of the coastline characteristics and of the development of the aquaculture sector in Turkey. Explanations were given about the placing of aquaculture, as there are many sites in more or less sensitive areas (there are 9 protected marine environments), and the relationships between aquaculture with tourism and recreation were discussed. As for EIA these studies are now starting to be requested, and one of the main difficulties for control and monitoring is the high number of administrations with responsibilities in the subject.

A. Fridman (Min. Environment, Israel)

This presentation started with a description of the Israeli coastline characteristics, the

Mediterranean coast and the Red Sea. As for the Red Sea, he explained the privileged characteristics of the Eilat Gulf and the recent development of aquaculture of the area with 2 farms and the great development of tourism (hotels, scuba diving, etc.), both endangering coral habitats.

A. Abrehouch (INRH, Morocco)

Mr. Abrehouch, from the INRH, Project Thon Rouge, M'diq, Morocco, made a presentation about the joint research project undertaken between Morocco and Japan for the domestication of the blue-fin tuna. Comments were made about the initial siting of tuna cages and the obtaining of broodstock. At present, after making the appropriate farm viability studies, the improvement of techniques and farming methods as well as the capture of live bait, are being developed.

N. González (ICCM, Canary Islands)

He explained the positive relationships between the Canary Island Administration, private sector and scientists (ICCM and IEO), which has given rise to the development of a good Strategic Plan for Aquaculture, which has 5 working groups: licensing, environmental planning, education, extension, management tools, and R&D. Details about the research areas of the Canarian Institute of Marine Sciences were also presented.

M. Kalamaras (Nireus, Greece)

After making a presentation of the Nireus aquaculture firm, he analysed the situation in Greece with respect to environmental aspects (regulation, control and planning) and ended his speech by pointing out a number of shortfalls in the system, the lack of a screening process, the fact that it is not obligatory to withdraw the unit once the farming has finished, the lack of environmental monitoring, and the lack of public information and risk assessment.

J. Guirao (Department of Agriculture, Murcia, Spain)

She began her speech by explaining the characteristics of the coast and the number of fish farms (1 sea bream and 5 tuna farms) that exist in this region. She also spoke about the administrative and environmental situation of the Autonomous Community of Murcia, the existence of strategic plans for aquaculture and that it is obligatory for all future installation projects to go through the EIA process. She also explained that licences are given for a 10 year period with a maximum of 30 years.

A. Kamarianos (Univ. of Thessaloniki, Greece)

He explained the particular case of the Bay of Tessalonika and its great environmental problem caused by some 300 farms (anoxic sediments, phytoplankton bloom, etc.). Details about the production methods and site characteristics of these farms, many unlicensed, were given. It is noted that this Bay, which accounts for a production of about 60,000 mt of mussels, also receives a high level of pollutants from the city and its harbour.

S. Abdel Rahman (NIOF, Egypt)

Dr. Rahman described the great historical tradition of aquaculture in Egypt that began with the farming of tilapia and sea bass hundreds of years ago. Most of the production is under extensive or semi-intensive systems and exports are few. As regards aquaculture and environment regulations, he is not aware of an environmental normative for aquaculture, whose most serious impact may be the use of growth hormones.

General discussion on practical experiences

Details were asked about the mussel production in the Bay of Thessaloniki, and a Greek representative expressed his hope that his administration would soon better regulate mussel culture activities.

A discussion was held on whether there is a lack of knowledge and studies about the impact of

aquaculture farms in the Mediterranean. Some participants disagreed with the overall opinion that there are few studies in the Mediterranean. Mr. Belmonte pointed out that the total cost of monitoring plans is not high, about 2% of the total cost of the installation of the sea bream and sea bass farms and 1.3% in the case of tuna, therefore he considered that the fish farmers should make a greater effort to promote that type of work.

A general discussion began about the holding capacity of coastal areas for aquaculture projects, in particular in how to calculate it. It was noted that this is an ecological and pedagogical concept that needs to be better defined taking into account the different production systems and their farming efficiency (greater yield with lower environmental cost), etc.

A brief debate followed on coastal management, and the need to harmonise aquaculture with other uses of the coastal zone, e.g. tourism.

It was pointed out that general methodology or guidelines are required, as well as the establishment of fundamental standards and parameters. However, in the opinion of some lecturers, this is not only a difficult task but also each site has its own characteristics and that is why each site should take different parameters into account.

In spite of everything, some participants were in favour of making an effort of conceptualisation, harmonisation and suggested working towards a methodological guide. To this respect some fundamental aspects are already known such as the fact that the sediment is one of the worst environmental compartments affected. Therefore we are in a position to determine more or less what fundamental aspects of the environment should be monitored.

Besides the control and monitoring of environmental parameters, it was noted that aspects of production management affecting environment (renewal rates, turbidity, feed efficiency, etc.) should be defined and contemplated in plan/areas for improvement.

Finally the FAO representative closed the discussion by talking on the need to exchange information through the organisation of congresses and seminars, etc., by drawing up management plans and the need to measure environmental impact.

Session 6: New developments

New developments in waste treatment for inland fish farms. *A. Moretti (STM, Italy)*

The lecturer started by explaining the pros and cons of methods used at present for waste treatment for freshwater and saltwater fish farming, e.g. gravity systems, mechanical systems, and mechanical gravity systems. He explained the difficulty of determining the production of solid matter from fish farms, which is a function of the quality of feeding, farm size, methods of administration, etc.

Based on preliminary results of a European project on mechanical gravity filters, he presented information on the design of filtration/thickening systems and on the stabilisation and stocking of solids. Solids should also be revalorized to be re-used instead of simply transferring the problem from sea to land. He concluded that with this technology it is possible to remove up to 80% of solid matter from fish farm outlets.

Discussion: A debate was established on the revalorization of the mud generated, its quantity and the need to include all these aspects in EIA, and the lack of legislation about the possible uses of mud in agriculture. In this sense, several people commented on the problems they were familiar with, due to the high salinity of the mud and hence the difficulty to apply them in agriculture. Mr. Moretti replied that it was necessary to improve techniques to reduce mud water content in order to solve this problem.

New developments in cages. *M. Beveridge (Univ. Stirling, UK)*

The lecturer began by reviewing existing sea cage fish farming technologies, their disadvantages

and areas of future development, such as moving them offshore to avoid conflict with other users, minimising cost and residue production.

Dr. Beveridge made an analysis of what the offshore cage structure should be like, materials, shapes, etc., in order to save money and prevent them from being damaged or for algae or animals to grow on them. He explained some of the techniques used to reduce residues (traps under the cages to collect waste, pumps, swirl concentrators, etc.).

He concluded his lecture by presenting the interaction of sea farm cages with wildlife, through escapees from the cages and the attraction of this type of cage for a varied group of associated fauna such as birds, other fish, scavengers, etc.

New developments in feeding systems. *M. Beveridge (Univ. Stirling, UK)*

Remarking that something like 5-25% of the feed is uneaten and lost, this amounting to as much as 10% production cost, Dr. Beveridge presented a series of technological advances in feeding systems, such as automatic ad-libitum (adaptive) feeders. The principles of adaptive feeders were presented.

He pointed out that a further reduction in feed losses require a better understanding of the feeding process, and to know what happens inside the cage to better understand how fish feed and thus improve the administration of their feed. Therefore, he defended scientific research that can add knowledge about the feeding habits of fish, which will help to design better diets, better feeders and better feed conversion indices.

Discussion: a debate was held on the type of feed to give (floating pellets, etc.), feeding times, advantages and disadvantages of automatic feeders in semi-submersible cages, expense of that type of technology, etc.

Multi-component systems. *F. Giménez (Univ. Alicante, Spain)*

After proposing multi-component systems as a tool for developing a more sustainable aquaculture, Ms Giménez presented the different components of the environment that may be affected by aquaculture activity. She presented and proposed different systems, e.g. the use of seaweeds as biofilters, the development of integrated diversified farming systems (fishponds, bivalve units and seaweed units), or integrated lake farming. She also proposed research into new feed, decreasing the supply of particulate material and increasing the recirculation around the farms.

Biomarkers. *F. Giménez (Univ. Alicante, Spain)*

After making an introduction about the different types of biological indicators, immunology bio-indicators of contaminants, and indicators species of environmental impact, Dr. Gimenez presented detailed information about the species used as pollution indicators, and the biological pollution indices, based on indicator species, on trophic strategies, on the structural heterogeneity, or those incorporating biomass.

She stressed the importance of the pre-operational campaigns, numerous control stations and asymmetric impact analysis.

Discussion: a producer attendant complained about the high number of different parameters that were proposed. A discussion was then held on the Administration's lack of criteria regarding the best indicators to use to determine the impact of a fish farm.

Final discussion

The FAO representative started the final discussion by pointing out the need to increase knowledge about relations between aquaculture and environment at all levels: scientific, administrative, farm, etc.

He made reference to the FAO Code of Conduct on Responsible Fisheries (CCRF) and its article on aquaculture development. He also explained the work done under the framework of the GFCM (General Fisheries Commission for the Mediterranean), i.e. the incorporation of environmental aspects on the workplans of the TECAM and SELAM Networks, and the Consultation on the application of article 9 of the FAO CCRF in the Mediterranean Regions. He ended by mentioning some areas of work that may be taken into consideration, e.g. promotion of more responsible production technologies and harmonisation of environmental impact assessment studies.

Proposals were made for studying the viability of offshore fish farms, and questions about where the limit lay or to what extent did the environmental perspective take priority over economic or industrial development interests.

It was noted that although great importance has been given to the impact of aquaculture on the environment, from the discussions it appears that some fish farmers are not yet aware of the necessity of following good environmental practices to respect the environment as much as possible but also for their own production to be successful. To this respect, a producer answered that there was a big gap between the formulations of the scientific world and the daily reality and need of the fish farmer.

The CIHEAM representative closed the seminar confirming the diversity of opinions presented by such a wide representation of participants: scientists, administrators and farmers. He noted that the Seminar, besides making a review of aquaculture issues related to the environment, was also conceived as a forum of discussion and that some of the key elements here identified will need a common approach by all the Parties involved.

Finally, after thanking all lecturers and attendants for their active participation, he indicated that the proceedings of the seminar would be published in the CIHEAM journal *Options Méditerranéennes*.

He also recalled how difficult it was to obtain sustainability and asked the participants to be patient and trusted that in forthcoming years the fruits of research would come about.

All participants agreed that there was still a large amount of work to be done and that producers and administration had to strive to work together for a sustainable development of the sector.