2. Method

2.1 THE DELPHI METHOD

In order to encourage a true debate about the opportunities, constraints and issues facing aquaculture in different regions of the world, it was decided to adopt the "Delphi method". The Delphi method was developed in the late 1960s as a forecasting methodology and works formally or informally, in large or small contexts. The results provided by Delphi represent the synthesis of the opinion of a particular group of experts and is not intended to produce statistically significant results. The value of the Delphi method rests with the idea it generates.

The word Delphi refers to the hallowed site of the most revered oracle in ancient Greece where advice and predictions were sought from the gods through intermediaries. Centuries later, the term was applied to a technique developed after World War II, much to the dismay of its founders. A set of procedures developed at the RAND (an acronym for Research and Development) Corporation designed to improve methods of forecasting came to be known as "Delphi" (IIT, 2006). The founders thought the term implied something "smacking a little of the occult" whereas, as a matter of fact, precisely the opposite is involved: the technique encourages feedback and transparency. It is a very useful means of obtaining forecasts when there is less than perfect information.

The Delphi technique was developed as a method for obtaining qualitative, rather than quantitative, forecasts. When change is non-linear and discontinuous, traditional forecasting methods based on time-series regressions are inappropriate and could produce misleading projections. The Delphi method recognizes human judgement as legitimate and assumes that the testimony of experts can provide useful inputs in generating forecasts. The technique therefore expects to have unanticipated results and is organized in such a way that innovative thinking is encouraged. There is no peer-pressure nor are there inhibitions due to hierarchical positions of experts; the process is anonymous, and spatially separate. Every opinion is given the same weight whatever the position or discipline of the expert. It appears therefore to be ideal for anticipating challenges and policies for a sector such as aquaculture that is new in much of the world, and whose development by 2020 will be influenced by many uncertainties and unknowns.

The Delphi technique is an adaptive iterative survey method. It offers a number of advantages; firstly, during later rounds of the process, questions can be formulated based on replies given earlier; this enables all experts to explore issues they may have never considered before. Secondly, it is anonymous, which avoids the limitations of group decision making such as deference to seniors or a dominating "expert". Thirdly, it may be relatively cheap and efficient, saving expense and time on face-to-face meetings, although there has been no cost-effectiveness comparison – in terms of budgets and time – of different participatory methods.

As mentioned above, the method presents several advantages, some of which are:

- anonymity – thus avoiding the limitations of group decision-making, e.g. over-dominant group members, deference to seniors;
- input of experts; and
- iteration with controlled feedback.

The Delphi technique has been applied to aquaculture in different contexts. It was used in the southeastern United Sates to develop criteria for aquaculture sustainability (Caffey, 1998). Out of three criteria (economic, environmental and social), the experts judged the first to be the most critical for sustainability.

In Chile, the Delphi method was used in 2003 as a means of evaluating the full potential of the aquaculture industry (Ministerio de Economía, 2003). The aim was similar to this study: to conduct a prospective analysis of aquaculture by examining the entire range of constraints and opportunities. A total of 167 experts participated in the survey, with the level of expertise ranked for each one. Stakeholder experts included not only producers from the aquaculture sector but also those involved in other sectors. Academics and government personnel were also invited to participate. The study was designed to explore prospects not only for existing but also potential aquaculture species and to provide guidance to Chilean policy-makers during 2003–2010.

Another Delphi study of aquaculture widened the stakeholder concept still further by including non-experts as well as experts. This stakeholder Delphi study was applied to the use or non-use of horizontally integrated aquaculture (Bunting, 2008). Such aquaculture offers the potential for mitigating some harmful environmental effects of cage culture, as well as being more socially acceptable, so the aim of the study was to determine the factors which prevented the adoption of this technology (Ridler *et al.*, 2007). Respondents (n=24) arrived at a general consensus on most constraints (primarily economic), but as the study mentions certain stakeholders were omitted, which may have biased results. A scoping exercise to identify stakeholders would be a valuable refinement for a similar expanded Delphi approach.

2.2 APPLICATION OF THE DELPHI METHOD IN THIS STUDY

Rather than a combined expert-stakeholder approach, the method used in this study relied only on experts from different regions. Delphi techniques often involve 15 to 60 participants but for this study 305 experts were initially surveyed. The experts were identified by FAO staff in seven regions of the world. The experts, who were either personal acquaintances or professionals selected after a scan of relevant publications on the Internet, were asked to share their views on issues and problems relating to aquaculture development in their region of expertise. Experts were not informed by FAO who else was participating.

Unfortunately, out of 17 experts initially identified for the Near East, only one responded to the first questionnaire; therefore the region had to be omitted from further rounds. As a result this report was based on six regions: Africa, Asia and the Pacific, Latin America, North America, Eastern Europe and Western Europe.

For questions where an impact/role of suggested factors was requested, participants were asked to rank each of their suggestions using a numerical scale from 1 to 5 in a column next to their suggestions. The resulting opinions were summarized (under category headings) and collated in an Excel format. The arithmetic median[1] and standard deviation (STDEV)[2] were calculated for the major category headings. These were then ranked from lowest to highest median value. If all participants agreed, the standard deviation would be zero. A STDEV close to 0 indicates a high degree of consensus. Whenever consensus was low (STDEV above 1), experts were asked to re-rate and/or justify their responses. All the results and semi-anonymous discussions were recorded and are available upon request.

2.3 RESPONSE RATE

In the first round, 305 questionnaires were sent out via mail; 54 responses were received. Respondents were assigned to different groups depending on their region of expertise: Africa, Asia and the Pacific, Latin America, North America, Eastern Europe and Western Europe (as explained previously, the Near East was excluded). The

[1] In a set of numbers, the median is the number separating the higher half from the lower half. It is found by arranging all the observations from the lowest to the highest value and picking the middle one.

[2] The standard deviation is a measure of how widely values are dispersed from the average value (the mean) of the sample.

TABLE 1
Breakdown of responses by round for the Delphi Prospective analysis of aquaculture development

Regions	Number of experts in region	Responses – first round	Responses – second round	Responses – third round
Africa	56	17	10	9
Asia and the Pacific	65	13	9	5
Eastern Europe	41	3	2	2
Latin America	36	4	5	4
Near East	17	1	NA	NA
North America	50	6	5	2
Western Europe	40	10	8	NA
Total responses	305	54	39	22

second-round questionnaire was mailed to the participants who responded in the first round. Thirty-nine responses were obtained in the second round. For the third round, a total of 22 responses were obtained (no third-round questionnaires were mailed to experts from Western Europe as all questions/issues were fully explored in the initial two rounds). The breakdown of responses by round is presented in Table 1.

2.4 QUESTIONS

The first round of the Delphi prospective analysis on aquaculture development asked experts:

i) to suggest factors which in their mind have contributed to today's aquaculture development; to rate the impact of these factors on the growth of aquaculture per region; to rate their expected impact/role on the growth of aquaculture per region over the next 15 years;
ii) to indicate other factors which might contribute to reduce aquaculture growth over the next 15 years; to rate the likelihood of occurrence of these factors; to rate their expected impact on aquaculture growth over the next 15 years if they were to occur;
iii) to indicate whether aquaculture should be encouraged per region; what the objectives of developing aquaculture should be; to rate the importance of each of the objectives listed;
iv) to list the major unexplored opportunities for aquaculture in the region; and
v) to suggest effective and practical means of developing aquaculture.

Responses in the first round helped define questions for the second and third rounds. In particular, the second round asked experts to suggest practical means to lessen/contain the impacts of those factors identified as having negatively affected aquaculture growth and expected to continue to affect aquaculture growth negatively in the next 15 years, or to suggest actions to implement those factors identified as positive for aquaculture development but unlikely to happen.

The text of the first-round questionnaire was slightly modified for Africa. Experts were asked what the main contributing factors for the slow growth of aquaculture had been in the region and to suggest additional factors that might contribute to reverse aquaculture development in Africa over the next 15 years. The reason for these modifications is that Africa has not enjoyed the same expansion of aquaculture as other regions, and so the Delphi questionnaire for that region focused on constraints and strategies for mitigating those constraints. These strategies were ranked for their potential impact and their likelihood of being implemented. Because of food insecurity and poverty issues in Africa and the potential contribution of aquaculture, a complete list of mitigating strategies for each constraint is attached even when there was not consensus. This lengthened the Africa Appendix (Appendix 1), but it is hoped that the ranking and the extensive list of suggestions will guide policy-makers devise appropriate strategies and policy instruments.