

# **METEOROLOGICAL SERVICE OF CHILE**



## **FINAL REPORT**

### **“LEARNING THROUGH DOING” PILOT PROJECT**

**STATE AGENCY OF METEOROLOGY SPAIN (AEMET)**

**WORD METEOROLOGICAL ORGANIZATION (WMO)**

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Santiago, Chile, November 2010

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## ABBREVIATIONS:

<b>AEMET:</b>	State Agency of Meteorology of Spain
<b>CODELCO:</b>	Copper Corporation
<b>CRIA:</b>	Regional Center of Agrometeorological Information
<b>DGAC:</b>	General Direction of Civil Aeronautic of Chile
<b>DMC:</b>	Weather Service of Chile
<b>FPP:</b>	Form of Participation in the Pilot Project
<b>INTESAL:</b>	Technological Institute of the Salmon
<b>MAP:</b>	Action Plan of Madrid
<b>MOP:</b>	Department of Public Works
<b>NAC:</b>	National Analysis Center
<b>NMHSs:</b>	National Meteorological and Hydrological Services
<b>PWS:</b>	Public Weather Services
<b>SIMETSAL:</b>	Information System for the Industry of the Salmon
<b>WMO:</b>	World Meteorological Organization

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## CHAPTER 1 - EXECUTIVE SUMMARY

- Beneficiaries:** Los Libertadores Border Crossing, farmers of Region VIII of the Maule, and the Salmon Industry of Region X
- Organization Executor:** Civil Aviation Directorate (DGAC) Weather Service of Chile (DMC)
- Sponsors:** State Agency of Meteorology of Spain (AEMET) and the World Meteorological Organization (WMO)
- Objective:** The main objective of the Chile “Learning Through Doing” (LTD) Pilot Project is to help raise awareness of existing and potential users of the variety of meteorological products and services that are available and the role of those services and products in socio-economic benefits to society. The Project is further to improve the capability of the Weather Service of Chile to provide products and services suitable to user needs.
- Description of the Pilot Project:** The Chile LTD Pilot Project consists of the application of a methodology to improve services to the public and to specialized users of the DMC and to incorporate evaluation of socio-economic benefits of those services. The Project is structured based on three stages: Planning, Implementation and Review.
- The Planning Stage was developed with the support of a WMO Consultant with whose assistance the criteria to select the economic sectors to be considered in the Project were established.
- The Implementation Stage was steered by a multi-disciplinary team consisting of personnel of the DMC, AEMET and WMO Consultants. This team was in charge of establishing operations for the different products and services.
- Finally, in the review and evaluation stage, the service delivery situation before the Project implementation is compared with the results obtained during its execution, in order to establish the achievements realized.
- Project Period:** Start: 2008  
End: 2010
- Participation of Organizations:** The execution of the Chile LTD Pilot Project was carried out with the collaboration of AEMET, WMO, through the Public Weather Services Programme (PWSP), public and private organizations, and three selected economic sectors.
- Results:** The results obtained from the Chile LTD Pilot Project can be summarized as follows:

- Development of a Meteorological Information System for three important economic sectors of the country; and

improving the visibility and capacity for development of the DMC;

- Creation of multi-disciplinary teams for development and continuous progress, with capacity to interact with users and to develop innovative response to their requirements;
- Development of 22 new products and meteorological services, as dictated by the real needs of the users;
- Improvement of skills for the professional and technical personnel of the DMC for the design, implementation and continuous improvement of the products and services that are provided to the Chilean public;
- Training in Socio-Economic Evaluation, thus enabling the quantification of benefits that the DMC contributes to the current and potential users;
- Access to Specific Information Systems (SIS), by users for their needs and requirements through a Web Page;
- Strengthening of dialogue and collaboration between users and DMC allowing improvement of the usage and application of meteorological products and services and optimizing operations ; and,
- Access by users to more and better meteorological information, for use in the processes of decision-making.

## **CHAPTER 2 – BACKGROUND**

### *2.1 The Madrid Action Plan (MAP)*

The WMO International Conference on “Secure and Sustainable Living: Social and Economic Benefits of Weather, Climate and Water Services”, was held in Madrid, Spain, from 19 to 22 March 2007. The Conference produced the Madrid Action Plan (MAP), with the general purpose of achieving in a period of five years, an increase of significant value for society of the information provided by the National Meteorological and Hydrological Services (NMHSs), in response to the challenges due to the rapid urban development, economic globalization, degradation of the environment, natural disasters and threats originated from climate change.

The principal recommendation of the MAP was that NMHSs would need to increase their efforts so that potential users, including the governments, are aware of the variety of existing products and meteorological services and the benefits that could result from them. This situation should result in increased dialogue with the users, so that they can specify their requirements and thus maximizing the benefits provided by NMHSs.

The Pilot Project entitled “Learning Through Doing” or “LTD”, is an integral part of the following actions of the MAP which are directly related to the Public Weather Services Programme (PWSP) of WMO. These Actions are as follows:

**Action 3:** Embark on capacity-building endeavours through the creation of education and training opportunities for both users and providers of weather, climate and water information in order to increase awareness of users to the opportunities afforded by weather, climate and water services, and to assist the providers of these services to understand more fully user requirements.

**Action 7:** Facilitate and strengthen dialogue and collaboration between providers and users of weather, climate and water information and services through international, regional and national platforms and programmes, and through the development of appropriate tools and methods.

**Action 9:** Strengthen existing, and establish new, operating partnerships between users and providers of weather, climate and water services to share responsibility for effective delivery of services, and evaluate their performance.

**Action 10:** Facilitate and strengthen the ability of NMHSs to effectively communicate weather services and products, through all forms of media, in such a manner as to maximize the benefits provided to society by the meteorological and hydrological community.

**Action 11:** Encourage the NMHSs and the social science research community to develop knowledge and methodologies for quantifying the benefits of the services provided by NMHSs within the various socio-economic sectors, in particular:

- Develop new economic assessment techniques including especially techniques of economic assessments for developing and least developed countries;
- Develop WMO guidelines on operational use of economic assessment techniques;
- Train national staff on the use and practical application of economic assessment of the benefits of services provided by NMHSs; and,
- Present results of economic assessments to governments and donors or international financial institutions with the goal of modernizing the infrastructure of NMHSs and strengthening their service delivery capacities.

## 2.2 *The Asunción Plan*

During the Meeting of the Directors' of Iberoamerican Meteorological and Hydrological Services in Asunción, Paraguay, 6-9 November 2007, the so called the Asunción Plan was prepared for the year 2008.

In the Asunción Plan there are detailed activities and projects to be realized for the NMHSs of the region and it emphasizes, among others, the initiation of two pilot projects on the subject of relations of NMHSs and key user sectors in countries selected in accordance with the criteria established by the "WMO Working Group on Socio-economic Applications of the Meteorological Services".

In this context, DMC was selected to execute the "Learning Through Doing" Pilot Project, to promote the products and services that it provides to its users, and to evaluate socio-economic impacts and contributions to sustainable development of the country.

## CHAPTER 3 - DESCRIPTION OF CHILE LTD PILOT PROJECT

### 3.1 *Preparatory activities prior to the execution of the Project*

Prior to the execution of the Project the “Meeting of the Chile Weather Service with Users” was organized in Santiago, Chile, 2008, in which there was representation from selected economic sectors that were to be considered in the pilot project. A training course on “Evaluation Methods of Social and Economic Benefits of Hydrometeorological Information” was held in Santiago, Chile, 2008, under the leadership of a WMO consultant.

#### 3.1.1 *Meeting of the DMC with users*

This activity was carried out at the Headquarters of the Chilean Weather Service (DMC), in Santiago, Chile, 4-5 June 2008. The principal activities agreed upon during the meeting, were proposed by Mr Jorge Ducci a WMO Consultant, Mr José Maria Marcos of the State Agency of Meteorology of Spain (AEMET), and Dr Sonia Quiroga from University of Alcalá.

Technical meetings were held to decide on the potential users to be invited, the discussion groups, the meeting facilitators, the agenda and corresponding presentations. There were 40 participants in the meeting drawn from different regions of the country.

The following were important users who presented their perspectives of use of meteorological information, namely:

- Ing. Andrés Ellena, Andean Division of the Copper Corporation (CODELCO);
- Ing. Carlos Berroeta, Andean Water Company L.T.D.;
- Ing. Red Ximena, Technical Salmon Institute;
- Agr. Pamela García, Agriculture Region VI;
- Ing. Waldo Moraga, Chief, Unit of Disaster Prevention, Sub-Secretariat, Department of Public Works; and,
- Dr Fernando Santibañez, Faculty of Agronomy, University of Chile.

In accordance with the planning of the Meeting, two sectorial groups were created. The first group included members of the Department of Public works (MOP), National Service of Geology and Mining (SERNAGEOMIN) and the Headquarters of Civil Aeronautics (DGAC). The second group was comprised of members of the Concessionary Companies of Inter-city Highways (Aconcagua and Itata), the Technological Salmon Institute (INTESAL) and the Forest National Corporation (CONAF). In both groups representatives of the central and regional levels of the Weather Service of Chile (DMC) took part. The Meeting identified thematic areas of potential sectors to be included in the pilot project.

The table below shows a summary of the projects agreed upon.

Sector(s):	Project(s):	Objective(s):
Mountain meteorology	Weather Forecasting System, for the Los Libertadores Complex	To establish an information system on conditions of the principal route that joins Argentina and Chile, to reduce the risks for passengers and cargo, and to facilitate clearing of the route.
Meteorology for road networks agents	Weather forecasting system, for (concessionary) private road networks agents	To provide information about critical precipitation, fog and freezing rain, to manage the safety of road users and maintenance operations.
Meteorology for primary economic sectors	<p>Prognoses system for agriculture, across the Regional Agrometeorological Information Centres (CRIA)</p> <p>Weather forecasting system for the salmon industry and manual fishing in the Regions X and XI.</p>	<p>To provide region- and product-specific information about meteorological parameters relevant to the farmers of the country.</p> <p>To provide information concerning critical meteorological parameters, which affect the productivity of salmon and its operational management. This information is applied to manual fishing.</p>
Meteorology for other sectors	Information system and rainfall prognoses, for Andean Waters L.T.D.	To provide rainfall forecasts for decision-making in the maintenance of sewer and storm water drainage networks.

The full information is contained in the document entitled “Consultancy Support to the Meeting of the Chilean Weather Service, with Users, Final Report”, Jorge Ducci (Santiago, Chile, June 2008).

The Meeting enabled the DMC to generate many ideas on how it could best serve its users in the future. Following the Meeting, analysis and evaluation work was carried out with the assistance of international advisers. As a result of this analysis, economic sectors were selected to be part of the Chile LTD Pilot Project.

### *3.1.2 Training Course on Evaluation Methods of Social and Economic Benefits of Hydrometeorological Services*

The course was held at the Headquarters of the DMC, in Santiago, Chile, 2-3 June 2008. The course was conducted by WMO Consultant Mr Jorge Ducci, in collaboration with Dr Sonia



Quiroga, who made presentations on evaluation of benefits of meteorological services. The main topics during the event included:

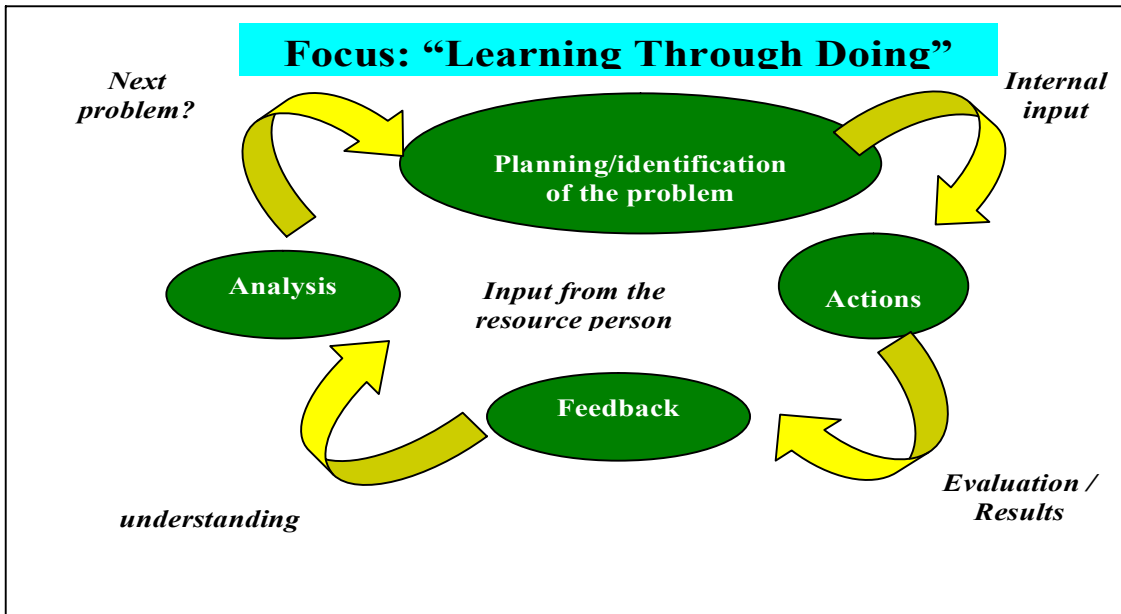
- Methodologies of measurement of socio-economic benefits of the meteorological services; J. Ducci;
- Case study: Evaluation of the system of early alert of ENOS for Mexico; J. Ducci;
- Case study: Economic evaluation of the rainfall network in Chile; J. Ducci;
- General economic scope of services of the Meteorological Services; S. Quiroga;
- Economic impacts of climate change on agriculture in Europe; S. Quiroga; and,
- Case study: Evaluation of the restoration of the integrated meteorological system of the Ap. AMB; G. Charpentier.

### 3.2 *Methodology of the Pilot Project (Conceptual Model)*

According to an eminent psychologist, Carl Roger (as cited in Kraft, 1978), “The only learning which significantly influences behaviour is self-discovered, self-appropriated learning.” Learning cannot be imposed. It can only be acquired through participation. Hence, the name of the non-conventional approach: “Learning Through Doing”.

In “Learning Through Doing”, the participant learns by a combination of action and reflection. The approach is oriented to the participation and centered on the results, with the development of the individual and shared work as two important components. This approach consists of a series of cycles of learning, each one comprising the following phases: planning, action, feedback and reflection. A cycle begins with a topic, which turns into the learning motivation. The next step is to analyze the situation and to make assumptions based on the current situation. Based on these assumptions, a plan with contributions from all interested parties should be prepared considering the appropriate measurements. The results of the actions are assessed and the lessons learned are identified. This constitutes the basis for verification and / or improving of the assumptions, hence the following learning cycle:

Approach of “Learning Through Doing”



The principal characteristics of this approach are:

- Learning by participation;
- Reflection on the action in order to verify the validity of the basic assumptions;
- Collaboration and participation of the diverse parts involved;
- Existence of an external agent who allows the creation of a learning environment; and,
- Capacity-building by participants.

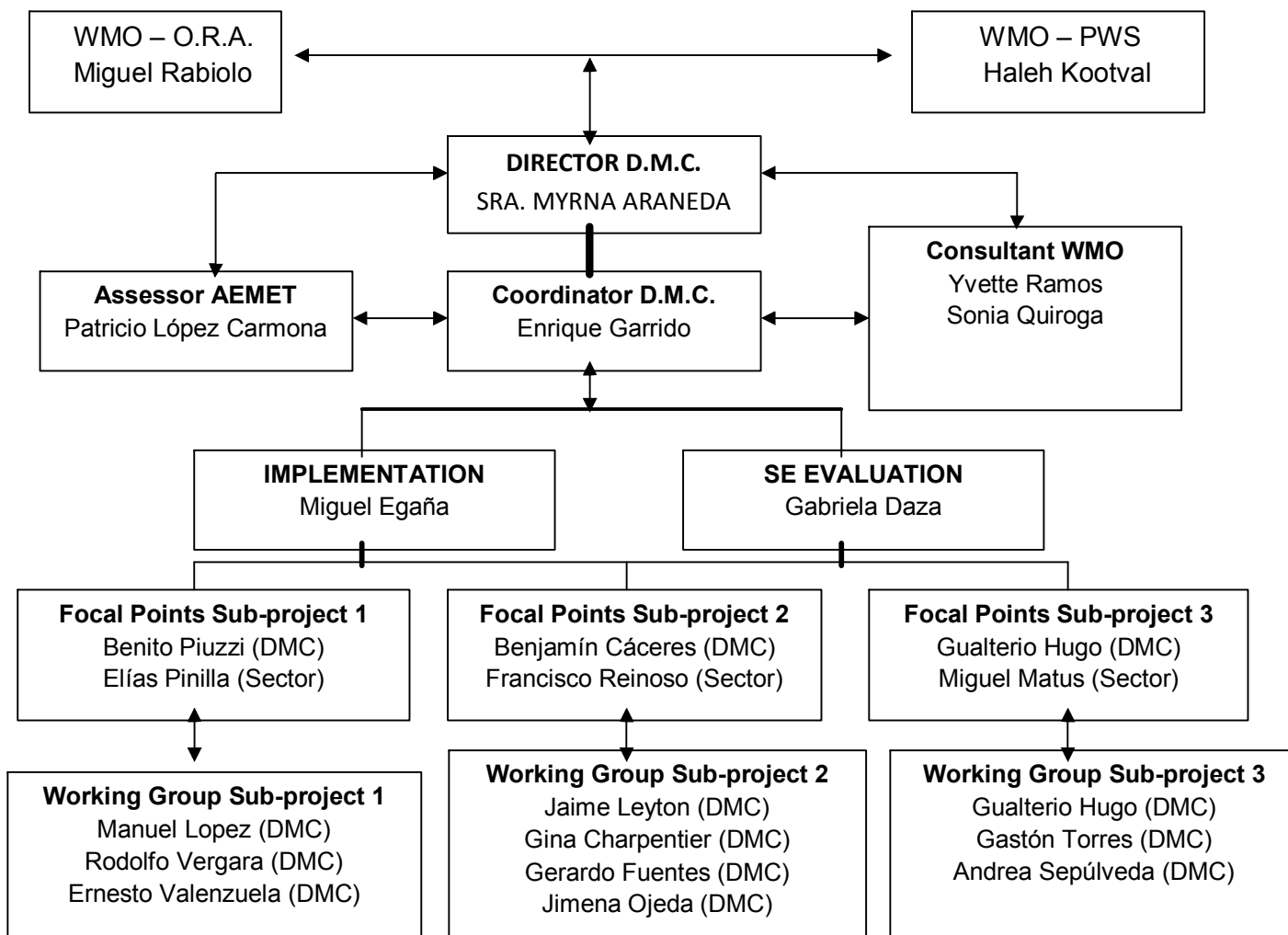
Taking Action Through Pilot Projects Within PWS: “Learning Through Doing” M.C. Wong and Hilda Lam, WMO Bulletin 57 (4) – (October 2008).

The methodology used in the Chilean Pilot Project was developed based on the above concepts, under the supervision and support of AEMET / WMO, incorporating a multi-disciplinary team from to the Chilean Weather Service and external organizations.

### 3.3 Functional Structure

The functional structure of the Chilean Pilot Project is described in the following diagram:

**CHILE LTD PILOT PROJECT MANAGEMENT CHART**



Sub-project 1: Weather Information System for the salmon Industry;

Sub-project 2: Weather Forecast System for the Los Libertadores; and,

Sub-project 3: Implementation of Agrometeorological Center for the VIII Region.

## CHAPTER 4 - EXECUTION OF THE PILOT PROJECT

The execution of the Chilean Pilot Project was carried out in agreement with the established methodology, considering three phases or clearly definite stages: Planning – Implementation – Evaluation.

#### 4.1 Planning Phase

The Planning Phase began with the commitment, on the part of the DMC, of taking forward the Pilot Project and the support from AEMET and WMO through the engagement of a consultant for the critical areas of the Project.

In this phase, the Project document was developed, establishing the scope, duration (2008-2010) and verification procedure, which would enable its development (Moodle Platform, WMO).

The working teams were formed in the DMC and contact points with the participating organizations were established, according to the table below:

<b>Name(s):</b>	<b>Associated Function(s):</b>
Director of DMC	Overall responsible for the Project
DMC General Coordinator	In charge of coordinating and controlling the activities and results of the project at DMC level
WMO Consultant(s)	In charge of providing the methodology that would be used in the achievement of the project goals
AEMET Assessor	Supervision and control of the overall development of the Project
Responsible for Marketing Plan	Supervision of the activities associated with the development of the Marketing Plan of the respective sub-projects in the DMC
Responsible for Business Plan	Coordination of the activities associated with the development of the Business Plan of the respective sub-projects in the DMC
DMC Focal Point	In charge of executing the activities related to the assigned sub-project
Sector Focal Point	Supporting the execution of the project by providing information to respective sectors
Work Teams of the respective Sub-project.	Executing the activities programmed by the respective focal points

The “Terms of Reference (ToRs) of the WMO-AEMET-DMC Project”, document described in detail the tasks and functions of for every member of the Project. These ToRs were confirmed and signed by the Director of the DMC.

Periodic Progress Reports were identified as a tool to support the implementation of the Project and were planned in accordance with the WMO Moodle platform for exchange of information between consultants, coordinators and teams in terms of meetings, agendas, techniques and a Work Plan detailing the activities to be undertaken, and were updated throughout the project development.

## 4.2 *Implementation Phase*

This phase involved the technical work for developing products and services required by the users of the respective sectors, preparing a Marketing Plan and later on, a Business Plan for every sector. The phase finished with an Implementation Plan that permitted the implementation of operational procedures for the respective information systems of the three chosen sectors.

### 4.2.1 *Marketing and Business Plans*

The implementation process began with a meeting between the working teams of the DMC and the WMO Consultant, Mrs Yvette Ramos, (DMC Headquarters, Santiago, Chile, 20-21 October 2008).

The aims of this meeting were to:

- establish contacts with representatives of the clients / users of the selected sectors and with the personnel of the DMC who would take part in the Projects;
- obtain the necessary and sufficient elements for the preparation of a detailed market research of the DMC for the selected sectors, through a Market Survey; and,
- present the characteristics of the remote platform that would allow continuing with the exchanges after the mission, for evaluation purposes.

As a result of the work done during the meeting, bases were established for the design of a Market Survey for each sector, which was applied later, evaluated and analyzed, in order to identify the needs of the users. Based on these results, the required products and services were designed.

The details of the design and the subsequent application of the surveys are contained in the reports prepared by the working teams of each sector (available in the WMO Moodle platform). The results of the analysis showed the main requirements for meteorological information by the sectors.

Some of the results of the evaluation of the surveys are indicated in the following table:

Sector(s):	Question(s):	Analysis of Answer(s):
Agrometeorology	Do you think that if you had access to meteorological information applied to agriculture, you would be able to better anticipate the adverse weather events and that this would help you improve the quality and quantity of the production in the agricultural and fishing sectors?	97.2% of the samples considered that access to agrometeorological information by the agricultural community, would enable them to better anticipate adverse weather events and hence to improve the quality and quantity of their production. Whereas 2.8% thought that it would help them anticipate adverse weather events only moderately.
Los Libertadores Border Crossing	<p>When you plan a journey, to what extent do you consider the effects of meteorological conditions (prevailing weather) on the Los Libertadores?:</p> <p>a) They are very important and they determine whether I take the trip;</p> <p>b) They are important but not determinant;</p> <p>c) I do not consider them in my planning;</p> <p>d) I travel without worrying about the weather conditions; or,</p> <p>e) If the conditions are bad I do not travel.</p>	<p>71% of the people questioned considered the meteorological information to be very important in planning the journey, and also that this information determined the decision to travel across Los Libertadores.</p> <p>15% considered the meteorological information to be very important to plan the trip, but the information did not determine the decision to take or not to take the journey, which meant that besides the weather information, other decisive factors were considered.</p> <p>About 14% did not consider the meteorological information to plan the trip and simply traveled without worrying about the weather.</p> <p>No one responded to option "e".</p>
Salmon Industry	<p>Do the products that the DMC provides satisfy your expectations from a Meteorological Service?</p> <p>If your answer is "No", please specify the reason.</p>	It is important to have forecasts with a bigger spatial resolution, considering specific environmental variables, such as the sea conditions and solar radiation, which are not included in current forecasts issued by the DMC.

As soon as this phase was completed, a Marketing Plan and later a Business Plan was prepared for every sector.

In the Marketing Plan for the three sectors, among other things a new line of products derived from the analysis of the requests by target users was established. Also, a description of the market, which was incorporated to the FODA analysis to guide the implementation strategy, was done.

In the respective Business Plans, the products and services to be implemented, as well as the resource requirements were identified. A marketing analysis was incorporated and the structure to follow for the implementation procedure was established. Finally, an estimate of future requirements of the respective meteorological products to implement was included (Annexes I and II contain the executive summaries of the respective Plans).

#### *4.2.2 Implementation Plan*

The Implementation Plan aims to initiate in operational terms, the development and dissemination of the various products and services provided in the Business Plan.

To carry out this activity three specific objectives were set to:

- design and implement in the DMC, the operational methodology for designing products and services, including the development of the computational tools, for the production and visualization of the products;
- include on the corporate Web page of the DMC, during the Pilot Project, a sub-page dedicated to the Pilot Project DMC-AEMET-WMO, in which the new line of products and developed services were included, allowing speedy access by users; and,
- train technical and professional personnel of the DMC, who would prepare the products and services, as well as teach users to optimize the use of the new line of products, along with the evaluation of the socio-economic benefits.

For the achievement of these targets, the DMC technical and human resources were utilized.

#### *4.2.3 Results achieved*

The results of all the work were realized when a Weather Information System was introduced as a functional structure of the DMC. Through this process, different work areas and equipment were integrated within the DMC in order to give continuity to the development and dissemination of products.

The construction of a Web page of the Pilot Project, in the corporate Website of the DMC, was another result achieved by the Project. This page is updated daily. It enables users to access information and it is also used to obtain feedback from them.

The products incorporated in the information system were continuously improved by a multi-disciplinary team in charge of optimizing the level of satisfaction of the users.

# DIAGRAM OF THE PROCESS

## WEATHER INFORMATION SYSTEM

### DMC-AEMET-WMO PILOT PROJECT

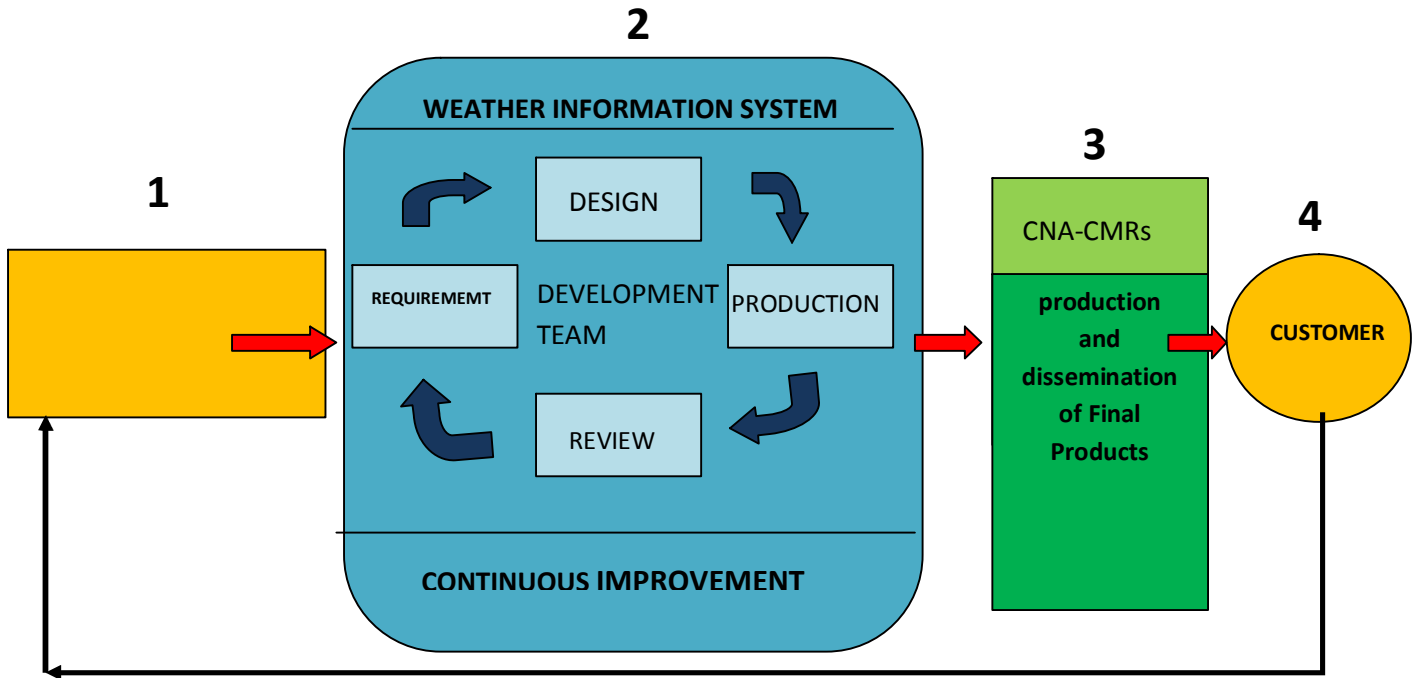
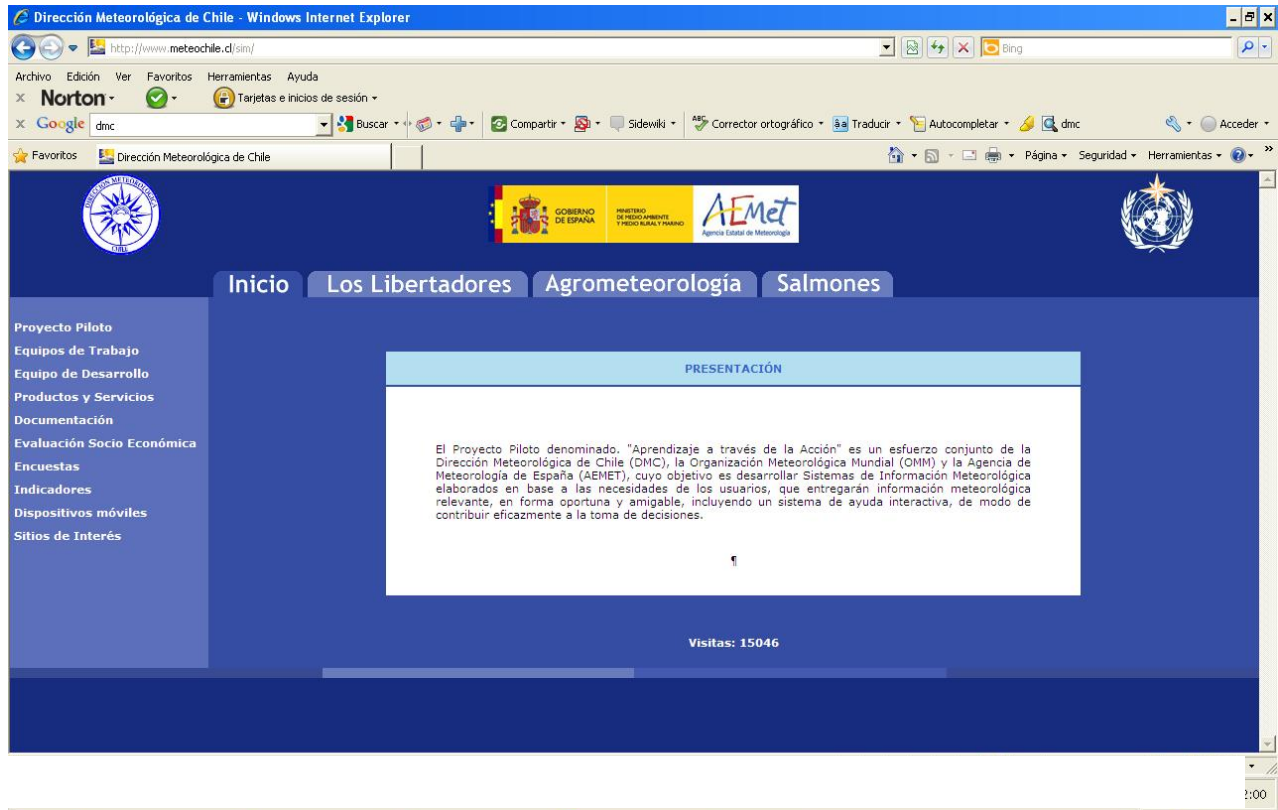


Diagram showing the process for the implementation of the products and services included in the Weather Information System of the DMC-AEMET-WMO Pilot Project



## WEB PAGE OF PILOT PROJECT



The continuous improvement team was made up of professionals and technical staff of different specialties of DMC. Its main function was to apply procedures of continuous improvement, based on interaction with the users.

### Listing of the “Continuous Improvement Team”

Name(s):	Specialties:
Enrique Garrido S.	Meteorologist
Rodrigo Delgado U.	Engineer (computer)
Gina Charpentier H.	Meteorologist M.Sc
Ricardo Alcafúz Q.	Meteorologist M.Sc
Luis Lazcano G.	Meteorological Observer
Benjamín Cáceres M.	Meteorologist
Miguel Egaña P.	Meteorologist M.Sc
Isabel Ramos R.	Meteorologist M.Sc
Sergio Rodriguez R.	Programmer

The control of the developed products is done using a Product Form (accessible in the WMO platform Moodle), in which the characteristics of every system developed and the record of improvements are registered.

### Example of a Product Form

<b>DMC-AEMET-WMO Pilot Project</b>	<b>PRODUCT FORM</b>		
	<b>Start:</b> January 2010	<b>State:</b> Operational	<b>Upgrade date:</b> 21 July 2010

<b>NAME OF THE PRODUCT:</b>	<i>Meteorological Information System (MIS), for Agrometeorology, Region VIII</i>
<b>USER(S):</b>	<ul style="list-style-type: none"> <li>• Small and medium scale farmers in the region;</li> <li>• Large producers in the agricultural and forestry areas in the region;</li> <li>• Regional authorities of the Department of Agriculture (SEREMI); and,</li> <li>• CONAF, FDF, FUCOA, INDAP, INIA and ODEPA.</li> </ul>
<b>SERVICES RESPONSIBLE FOR THE PRODUCTS:</b>	Chilean Weather Service (DMC), National Analysis Center (CNA) and Agrometeorology Office
<b>DESCRIPTION OF THE PRODUCT(S):</b>	<p>The information System for Agrometeorology, is an integrated meteorological product, on the DMC Webpage (DMC-AEMET-WMO Pilot Project) and includes the following sub-products:</p> <ol style="list-style-type: none"> <li>1. Weather forecast for the agriculture, by geographical areas (two daily forecasts);</li> <li>2. Meteorological warnings and alerts for agriculture (accessible also from cell phone with Internet capability);</li> <li>3. Dekadal bulletins for the region: Agrometeorological bulletin and</li> <li>4. degree days bulletin;</li> <li>5. 3-Month regional forecast of degree days;</li> <li>6. 72-hour forecast maps for precipitation, maximum temperature, minimum temperature and wind speed and direction;</li> <li>7. Synoptic Information (current and predicted satellite image); and,</li> <li>8. Requests (via e-mail).</li> </ol>
<b>SCOPE OF THE PRODUCT:</b>	This product includes seven homogeneous geographical areas of Region VIII. The agrometeorological forecasts are updated twice daily. Warnings and alerts are updated regularly.
<b>ASSOCIATED DOCUMENTS:</b>	(DMC-AEMET-WMO) Pilot Project Marketing and Business Plan.

<b>TECHNICAL REQUISITES:</b>	<p>The technical requirements are:</p> <ul style="list-style-type: none"> <li>• Meteorological and Agrometeorological information, validated by the CNA and the Office of Agricultural Meteorology of the DMC;</li> <li>• Should be published using a clear and understandable language for the user;</li> <li>• Must be regularly updated and accessible to the user; and,</li> <li>• Must be evaluated and subjected to continuous improvement.</li> </ul>
<b>REQUISITES OF ACCESSIBILITY:</b>	<p>Permanently accessible by Internet for the users (<a href="http://www.meteochile.gob.cl">www.meteochile.gob.cl</a>).</p>
<b>VERIFICATION POINTS:</b>	<ul style="list-style-type: none"> <li>• Verification of reliability and timeliness of information periodically done by the CNA and the Office of Agricultural Meteorology;</li> <li>• Review of the customer satisfaction surveys; and,</li> <li>• Review of the indicator.</li> </ul>
<b>PERIOD:</b>	<p>During the DMC-AEMET-WMO “Learning Through Doing” Pilot Project.</p>
<b>DELIVERING CONDITIONS:</b>	<p>Free access to the product by the user.</p>
<b>REMARKS:</b>	<p>Products are submitted to a continuous improvement process.</p>
<b>INDICATOR:</b>	<p>N° of monthly visits to the Agrometeorology menu, of the DMC-AEMET-WMO Project webpage.</p>
<b>IMPROVEMENTS DONE:</b>	<ol style="list-style-type: none"> <li>1. Warnings and alerts can be accessed from cell phones with Internet capability. (<a href="http://www.meteochile.gob.cl/sim/movil">www.meteochile.gob.cl/sim/movil</a>) (20 April 2010);</li> <li>2. An online survey form (20 May 2010) is included in the Agrometeorology menu; ,</li> <li>3. Three-month climate predictions are updated monthly (7 June 2010);</li> <li>4. Climate Bulletins for temperature and for each station of the region (5 July 2010);</li> <li>5. General Information about population and principal agricultural activities is included for some counties of Region VIII (12 July 2010);</li> <li>6. Capacity to print products contained in menu is included (12 July 2010); and,</li> <li>7. The “Meteogram“ menu is included, which provides information on meteorological parameters for the counties (15 July 2010).</li> </ol>

A summary of the developed products is shown in the following table:

<b>Total of Products Developed:</b>	<b>Sector: Los Libertadores</b>	<b>Sector: Agrometeorology of Region VIII</b>	<b>Sector: Salmon Industry</b>
22	4	9	9

**4.3 Evaluation Phase**

The review and evaluation phase involved the analysis of the impact of the pilot project both on the executing organization, in this case the Chilean Weather Service, and on the internal and external users. For the development of this phase, information from indicators, analysis by the coordinators and user surveys was used.

**4.3.1 Evaluation of operational aspects**

One of the items that the Project evaluated was related to the indicator associated with the number of visits to the webpage of the Project from the moment when it began to function operationally. The indicator took into account the monthly number of visits from users outside of the DMC. This value was on graphed a monthly basis and was published on the Project Website.

Also, an evaluation of the products which were most visited within every menu was conducted. The results showed that among the different products for every sector, those related to the weather forecasting were the most visited.

Another item which was evaluated was the response to the online surveys received during the Project period.

In the following graph the results of the indicator of visits to the website obtained during the months of operation are shown.

**Graph: Number of External Visits to the Project Website in 2010**



As shown in the graph, on average, there were about 1,120 visits per month, and 15,200 visits during the whole period. A higher number of visits occurred during the autumn and winter months, with April being the highest.

The above figures demonstrate that it was possible to keep an important number of regular users visiting the website. This can be interpreted as confirmation of the usefulness of the information provided on the website.

An analysis of the online surveys sent by the users, shows the following:

- The people surveyed thought that the information was very useful;
- 100% of the people surveyed indicated that they visited the website often;
- The surveyed people confirmed that the information could be interpreted easily.

Among the suggestions received, those related to improving the presentation formats, optimizing the communication system for alerts, and including more detailed recommendations are outlined in part VII of this report.

#### *4.3.2 Evaluation of socio-economic benefits*

With regard to the evaluation of the socio-economic benefits, the methodology suggested by the consultants was applied, with adjustments in accordance with the availability of information contributed by the users. These are illustrated below in the case of all three sectors used in the Pilot Project.

##### *4.3.2.1 Case I: Information System for the Los Libertadores: Evaluation of a closed day*

Among the responsibilities of the administrator of the Los Libertadores pass is the closure of the border pass, for two following main reasons:

1. Meteorological extremes related to blizzards and snowfalls. There are currently no records of these events available, nor have critical levels been established for operational purpose;
2. Uncertainties related to frontal systems forecasts, to allow for about two hours of good weather, which is the estimated time that it takes to cross from Guardia Vieja (1,600 Metres Above Sea Level (M.A.S.L)) to the same altitude in the Argentine sector.

The closing of the route takes place in Guadia Vieja (km 178), where there is a police control unit.

The danger of avalanches occurs during thunderstorms and, sometimes, on the following day, and is a threat for the whole of the G20 international highway. From the beginning of a thunderstorm, efforts are made so that vehicles circulate safely, do not park on the highway in places

where shelter does not exist, and where life might be at risk if one is not carrying the necessary equipment.

Therefore, an accurate forecast would reduce border closures in two respects:

1. It would allow for a reduction in the preparation time for snow operations; and,
2. It would also reduce the overall number of closed days due to erroneous forecasts. Considering that one day of closure was quantified in dollars (November 2010), (see table below), it was possible to quantify the economic benefits of the correct weather information:

<b>Study Mop-Road Year 1996</b>			
Currency	<b>1996</b>	<b>1996</b>	<b>2009</b>
Days Closed	15 days	Daily	Daily
Total	<b>US \$ 30,914,000</b>	<b>US \$ 2,060,933</b>	<b>\$ 2,349,083</b>
<b>Toll Tickets</b>	<b>Daily Value Sept. 2009</b>		<b>2009</b>
	Chilean Pesos: CH\$ 538,483		US \$ 1,013
<b>Total daily value September 2009</b>			<b>US \$ 2,350,096</b>
<b>Total daily value November 2010</b>			<b>US \$ 2,410,828</b>

#### **Costs avoided per Closure day during 2009 and 2010.**

In 2009, the Highway Authority began publishing international border crossing closures, differentiating between snowfalls and weather forecast situations. The snowfalls correspond to days when a meteorological phenomenon is certain (i.e., when it is snowing), and the weather forecast situation which corresponds to those days for which snowfall and / or sleet forecast was issued. In 2009, there were 13 days of closure due to forecasted snow. For eight (8) days, the forecast were fulfilled in accordance with the indication by the Highway Authority; however, for five (5) days, the closures were due to erroneous forecasts. In 2010, there were a total of ten (10) closure days, eight (8) of which were due to actual snowfall, and two (2) due to forecast. This demonstrates an improvement in the mountain forecast by the Service and more trust in the forecast by the Provincial Government. To this end, there was a reduction in the closure of the Los Libertadores border of three days, which equates to USD \$ 7,232,484.

<b>Years 2009-2010</b>			
<b>Forecasts</b>	<b>2009</b>	<b>2010</b>	<b>Difference</b>
Certain	8	8	
Forecasts	5	2	3
Days Closed	13	10	
<b>Total costs avoided (in US Dollars)</b>			<b>US \$ 7,232,484</b>

#### 4.3.2.2 Case II: Agrometeorology - Region VIII

##### Methodology used in the evaluation

In the planning phase of the economic evaluation, information related to the damages and/or losses caused by meteorological phenomena which took place during the previous periods (i.e., years 2007-2008) was collected. This was done in order to establish a basis for comparison with fewer losses which could happen with improved forecasting.

In the implementation phase, a user was identified who could participate in the overall Project process. This user would also provide firsthand information with regards to the information used and the loss reduction due to meteorological phenomena. On this occasion, Company *C rpora S.A.* was the partner selected.

In the evaluation phase the compiled information was studied and the following methodology was applied:

Several types of meteorological phenomena which affect agriculture were identified, and amongst them, frost was chosen for this particular study. This was due to the fact that some mitigation action could be taken for such a phenomenon. All relevant details were also identified such as: square meters planted, production/yield per hectare and prices.

A fact of vital importance concerning the success of this economic evaluation was the interaction with the user in order to understand the mitigation method used for frosts. Smoke was used as a mitigation element, taking around 12 hours for the implementation of the procedure.

We compared the impact of the 2007, when there were no special forecasts for frosts for the region and found that frost affected the performance of the plantations. Of the sample of selected products, a different impact factor was used for each type of cultivation, and it was estimated, in accordance with the indication by Regional Secretariat of Minister of Agriculture of the Bio-Bio Region and of the Center of Agriculture and Environment of the University of Chile (AGRIMET), that the correct mitigation for frosts, as a result of a good forecast, reduces the impact of frost by 50%.

The following table indicates the cultivation of the sample and the evaluation of the minor losses as a result of mitigation measures, made possible due to timely and accurate forecasts

Products	N° hectares	Yield per hectares quintals/h ectare (qq/ha)	Price	% of hectares affected	Production without frosts (Millions of CH \$)	Losses due to frosts without forecast (Millions CH \$)	Losses with frosts mitigation with forecast (Millions CH \$)
Wheat	72,000	51	11,500	14,40%	42,228	6,080	3,040
Oats	23,000	45	8,500	13,50%	8,797	1,187	594
Corn	9,600	125	10,200	6%	12,240	734	367
Rice	4,200	36	18,475	6%	2,793	167	84
Beans	3,400	14	38,167	0,80%	1,816	14	7,2
Lentils	800	7,5	50,000	0,70%	300	2,1	1
Beet	14,000	94	27,560	13,30%	36,268	4,823	2,412
Chicory	3,000	54	38,000	11,00%	6,156	677	339
Tobacco	364	3,250	1,233	5%	1,458	73	36
Lupin	1,500	30	5,300	40%	238	95,4	47,7
Vineyard	15,613	8,500	6,667	18%	884,780	159,2	79,630
<b>Total US \$</b>				11,70%	997,078	173,117	<b>86,558</b>
<b>Total US \$</b>							<b>173</b>

#### 4.3.2.3 Case III: Information system for the Salmon Industry

##### Methodology of Evaluation

##### Determining the cost of closing the port for the customer

The losses of the Salmon Industry, estimated by INTESAL in 2007, equated to 180,400 tons. Considering that the client participating in the Pilot Project has a market share of 9.2%, the losses to this particular client are equivalent to 16,597 tons. Considering that a ton of salmon costs US \$ 4,000.00 (according to the SurySur.net Website, as of 15 November 2010), the 2007 loss to the Pilot client was US \$ 66,387,200.

According to the information provided by the Marine Government of Port Montt, there were in 2007, 185 cases of closures of 16 Salmon Industry ports, impacting the Industry to the total loss of US \$ 358,850.

To determine the economic value of the meteorological information provided by the DMC, the methodology used consisted of determining the number of occasions that Port authorities opened the ports as requested by the Pilot Project client, which was based on the information provided by the



Service. The information only includes two seaports, Melinka and Quellón, (the total number of ports for the Salmon Industry is sixteen).

According to the reports from the Lieutenant Commander in charge of the marine operations of the harbor master's office in Port Montt, the authorizations of opening the closed seaports can not be specified due to the fact that the port only authorized an operation for some hours, and activities which were not registered as open seaport.

On the other hand, the customer may not always have a record of the request concerning the opening of seaport, as often the communication with the harbor master's office is by cell phone.

This lack of information has not allowed determining the savings resulting from reduced seaport closure days in 2010.

Despite the lack of information regarding the management carried out for the opening of ports by the Pilot Project client, we may find the perfect correlation of the 16 ports for salmon industry, versus two (2) seaports which were feasible to operate due to the information provided by the DMC; it can be inferred that from the 185 closures corresponding to 16 ports, 23 of these would correspond to two (2) ports with meteorological information available for the opening operation.

In a simple calculation, if the total of the closings had been managed, the total of minor losses, according to the above model, would be around US \$ 8,298,400.

## **CHAPTER 5 - COSTS AND FINANCING**

The costs associated with the implementation of the Pilot Project were related to the payment of travel ticketing expenses of external focal points from Puerto Montt and Concepcion, respectively. This cost was US \$ 500. Financing was provided by the WMO through the Regional Office for the Americas.

The costs associated with travel and ticketing expenses for DMC personnel were provided by the DGAC.

The costs associated with the hiring and transfers of international consultants were provided by AEMET-WMO.

## **CHAPTER 6 - BENEFITS OF THE PROJECT**

### **6.1 *Benefits for the Weather Service of Chile***

The benefits DMC gained from the Pilot Project are as follows:

- Incorporation of the *Meteorological Information Systems* concept within the functional structure, which will replicate the methodology used in the Pilot Project, in other important economic sectors of the country, and improving the visibility and development capacity of the DMC;
- Creation of multi-disciplinary working teams, capable of interacting directly with the users and developing innovative responses to user requests by incorporating continuous improvement;
- Increasing the quantity and quality of meteorological products and services, focusing on the real needs of the users;

- Improving the skills of the professional and technical staff of the DMC, to design, and implement continuous improvement of products and services which are provided to communities; and,
- Training in socio-economic evaluation methods, to quantify the benefits that the DMC contributes to current and potential users.

## 6.2 *Benefits for the users*

- Gaining expeditious access to the Meteorological Information Systems, specific to their needs and requirements;
- Facilitating and strengthening dialogue and collaboration with the DMC, which will allow improving the usefulness of the products and meteorological services and optimizing operational partnerships;
- Having access to more accurate meteorological information for better decision making; and,
- Providing specific advice on weather which could be applied to the different economic sectors.

## **CHAPTER VII - SUGGESTIONS AND RECOMMENDATIONS**

Among the recommendations arising from the implementation of the Chile Pilot Project, the following are the most important:

- The Pilot Project is an excellent tool to initiate a process of improving the relationship of the Meteorological Services with the users, but the process must not end with the Pilot Project. It is necessary that what was learned in terms of the methodology be incorporated in the organization in order to have continuity and sustainability over time. It is therefore recommended that as soon as the Project is finished, to create a multi-disciplinary specialty unit for the development and implementation of products and services which would have a high-impact on the different economic sectors; and,
- According with the experience learned during the development of the Pilot Project, training for end-users is considered of the utmost importance and should not be overlooked nor neglected once the pilot project is finished.

### Acknowledgments

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## **ANNEX I - MARKETING PLANS FOR SECTORS**

### **MARKETING PLAN**

#### **SUB-PROJECT: LOS LIBERTADORES**

##### **Executive Summary**

The Los Libertadores site is located in the region of Valparaiso and is a control pass for the international bi-oceanic route that connects Argentina, Brazil, Chile, Paraguay and Uruguay. Located at 3,000 m in the Cordillera de los Andes, it connects the country with a potential market of 190 million persons. The market for meteorological products and services is comprised of three principal users: Public services that operate in the Complex, tourists and both freight and passenger transportation companies. The need for each of these sectors presents different characteristics, which forces a different design of products and services to meet those needs.

The new line of products designed, consists of the following products and services: daily weather forecasts, warnings and / or alerts. Each of these products and services will be tailored to the particular needs for the respective user sectors.

The overall objectives of the sub-project are to improve the image of the DMC among the users and to support the operation of the control border office with timely and reliable meteorological information. A strategy for achieving these goals is a selected distinctive line of products / services, different for each specific user sector. This decision was reached after conducting a FODA analysis.

Finally, the assessment, monitoring and continuous improvement of products and services, will be realized based on the behavior of indicators, which will be designed and implemented during the development of the Project.

A Final Evaluation Report will terminate the activities of the Project.

### **MARKETING PLAN**

#### **SUB-PROJECT: AGROMETEOROLOGY**

##### **Executive Summary**

Faced with adversity or benefits resulting from meteorological events, operational agrometeorology constitutes an essential tool to support the field activities that the farmers carry out. The selected region presents a variety of conditions from the agroclimate viewpoint. Thus, the INIA defines different agro-ecological zones with different characteristics, potentials and agricultural importance. They are: the coastal dry land, coastal mountain range, interior dry land, central plain, Andean pre-mountain range and the Andes mountain range. On this basis, the Region has, as central feature, an enormous variety of production alternatives and, therefore, of possible exportation

business, and, of course, open to use tools such as meteorological support for increasing and improving agricultural production.

The market for products and meteorological services for the agriculture in Region VIII is composed mainly of farmers who are involved in the medium and large-scale agriculture in the area. This market segment has as principal characteristic, the fact of using the information for decision-making in the field. The Bío-Bío Region has had, in the last decade, a Gross Geographic Product industry (excluding the primary forest sector) generally over US \$ 450 million dollars per year. In recent years, the Region has exported near or even above US \$100 million dollars, averaging around 20% of the regional sectoral Gross Geographic Product.

The objective of the sub-project is to implement a new line of meteorological products designed to meet the demand of specialized meteorological information for the medium and large agriculture of Region VIII. Among the products and services to be offered are: twice daily weather forecasts, agrometeorological alerts (frosts, forest fires) and seasonal agroclimate forecasts (three (3) months) for planning purposes.

For the implementation of this new product line, there will be an integration of the analysis centers of the DMC in Santiago and the Agrometeorological Information Center (CRIA) of Region VIII, to develop a joint methodology which will allow access to the products and services, in a timely and reliable manner.

Finally, the assessment, monitoring and the continuous improvement of the products / services, will be realized based on the behavior of indicators, which will be designed and implemented during the development of the Project.

A Final Evaluation Report will terminate the activities of the Project.

## **MARKETING PLAN**

### **SUB-PROJECT: SALMONS**

#### **Executive Summary**

The Salmon Industry is an activity that brings large economic and social benefits to the country. Currently, it represents 65% of the fishing exports and employs either directly or indirectly nearly 50,000 people. However, in the last year a virus called Infectious Salmon Anemia, known by its acronym ISA, has killed a million salmons and shaking the third exporting industry of Chile.

The Salmon Industry activity develops principally in fjords and channels in southern Chile, where the weather is a determining factor in different stages of the production chain.

The Salmon Industry in Regions X and XI is composed mainly of: INTESAL (Technological Institute of the Salmon); technology platform spokesman of the Association of the Salmon Industry AG

(Salmon Chile) and other non-associated producers and suppliers. This highly technical and demanding market requires meteorological information through the production chain. Emphasis is put on the importance and need of the provision of forecasts with better spatial resolution, also taking into consideration specific environmental variables such as sea temperature and solar radiation.

The objective is to implement a new line of meteorological products to satisfy the demand for specialized meteorological information, to efficiently support the operation and planning of activities developed by the Salmon Industry in the Regions X and XI. The products and services will allow the user, to know the meteorological conditions for the day including precipitations and winds, with a projection up to three days in order to mitigate meteorological risks.

Finally, the assessment, monitoring and continuous improvement of products and services, will be realized based on the behavior of indicators, which will be designed and implemented during the development of the Project.

A Final Evaluation Report will terminate the activities of the Project.

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## **ANNEX II – BUSINESS PLANS FOR SECTORS**

### **BUSINESS PLAN - LOS LIBERTADORES**

#### **Executive Summary**

The DMC, AEMET and WMO are developing a Meteorological Information System for the facilities located in the international crossing border named “Complejo Los Libertadores”. This new line of products aims to deliver excellent meteorological information (principally weather forecasts) in a timely and user friendly format, offering an effective system of interactive help, which allows 24-hour monitoring of the meteorological conditions that will affect Los Libertadores area, thus efficiently helping the users in their decision-making.

To operate this system, DMC has all the necessary meteorological instruments and equipment to allow for continuous monitoring of weather conditions and progression of main meteorological conditions related to transit through Los Libertadores. A complete system of surface and upper-air information, complemented with a good capacity to receive high-resolution satellite images and use of numerical models ensure adequate monitoring of the weather. For this work, a qualified team of meteorologists and weather technicians, with extensive experience in forecasting in the area, is available on a 24-hour shift system.

The target market of this information system will be governmental users, transportation vehicles (trucks and buses), tourists and the general public. The principal characteristic of this market is the seasonality, which leads to a high-standard quality for products and services during the winter period. For this reason, a continuous improvement processes was implemented.

As a means of capturing the target market, it has been planned to start the service on a trial basis. During this period, the aim would be to gain trust of users and promote and encourage the need for new products.

During the first years of the system operation, it is expected to gather as much technical background as possible to evaluate the operations details. In a longer-term perspective, it is anticipated to incorporate progress in the design and to include Quality Management Systems (QMSs).

### **BUSINESS PLAN - AGROMETEOROLOGY**

#### **Executive Summary**

The Meteorological Information System dedicated to Agriculture being developed by DMC, AEMET and WMO, is to meet the needs for meteorological information applied to the agricultural sector of the Bío Bío Region. The agrometeorological products offered are intended to provide forecasts that cover different climatological sub-regions in the Bío Bío Region, incorporating Frost Alerts, Forest Fire Alerts and Agrometeorological quarterly perspectives, which will form an operational tool for effective operation and planning for the farmers in the area.

DMC has more than 19 years of experience in meteorology applied to agriculture, covering information from the Coquimbo Region to the Maule Region. DMC has professionals, technical elements and necessary meteorological teams, which allow for continuous follow-up of the meteorological conditions and visualization of the spatial and temporal changes of all the atmospheric variables linked to farming that are of interest for both the forest and agriculture sectors. All of this along with a team of meteorologists manages three-dimensional meteorological information, based on a network of surface and upper-level stations and the support of high-resolution satellite images, along with the results of numerical modeling of the atmosphere.

In the Marketing Plan, the market sector associated with this system will be connected to the medium and large scale agriculture which is evolving towards the innovation and technological development, to respond to the demand for high-quality products desired by the national and international markets.

The selected services will have a trial run stage, with free distribution, so that the product becomes known and positioned on the market, to allow access and familiarizing the user with the benefits and practical applications of the product. After establishing the product, there will be a cost evaluation which does not involve profit and is based on the cost of operating the system, considering the public service character of DMC.

## **BUSINESS PLAN - SALMONS**

### **Executive Summary**

The DMC, AEMET and WMO are developing a Meteorological Information System dedicated to the salmon industry (SIMETSAL). The new line of products generated by this System is intended to deliver relevant weather information in a timely and user friendly format, offering an effective system of interactive help, which allows 24-hour monitoring of meteorological conditions that will affect the Salmon Industry, thus efficiently helping the decision-making by users.

To operate this system DMC, has all the necessary meteorological instruments and equipment to allow for continuous monitoring of main weather conditions and progression of the main meteorological conditions related to the salmon industry. A system of surface and upper-air information, complemented with a good capacity to receive high-resolution satellite images and use of numerical models, ensures adequate monitoring of the meteorological conditions. For this work, a qualified team of meteorologists and weather technicians, with extensive experience in forecasting in the area, is available on a 24-hour shift system.

The SIMETSAL target market is composed of a variety of manufacturing companies and suppliers of salmon and trout in Regions X and XI. The principal characteristic of this market is the high-technical level, which is in turn translated into a demand for high-quality products and meteorological services that it needs. For this reason, ongoing training processes will be implemented.



As a way of capturing the target market, it has been planned to initiate the service on a trial basis. During this period, it is intended to optimize methodologies and efficiency of available tools within the DMC and to build confidence in users.

Later, the products and services would be delivered, bearing in mind the character of public service of the DMC. During the first years of system operation, it is expected to gather as much technical background to evaluate the operations details. In a longer-term perspective, it is anticipated to incorporate progress in the design and to include Quality Management Systems (QMSs).

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