Strategic Development Plan for the Croatian Meteorological and Hydrological Services

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ISBN 978-951-38-6627-3 (URL: http://www.vtt.fi/publications/index.jsp)
ISSN 1459-7683 (URL: http://www.vtt.fi/publications/index.jsp)

JULKAISIJA – UTGIVARE – PUBLISHER

VTT, Vuorimiehentie 3, PL 1000, 02044 VTT
puh. vaihde 020 722 111, faksi 020 722 4374

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Technical editing Anni Kääriäinen

Series title, number and
report code of publication

VTT Working Papers 76
VTT–WORK–76

Author(s)
Leviäkangas, Pekka, Hautala, Raine & Mäkelä, Martti

Title

Strategic development plan for the croatian meteorological and hydrological services

Abstract

This publication describes the strategic development plan for the Croatian hydro-meteorological services (DHMZ). The development strategy contains the following elements: i) vision for 2020, ii) strategies until 2010 supporting the vision, and iii) action plans for implementing the strategies. The strategies are formulated to cover the following areas:

- Observation network and infrastructure
- IT and its architectural cornerstones
- Production process of hydro-meteorological service products
- Organisational structure
- Human resources and capacities
- Physical facilities
- Economy, budgeting and finance.

The plan is motivated by the goal of increasing the competitiveness and customer-orientation of DHMZ. During the course of drafting the plan, numerous interviews and two major workshops were held in Finland and Croatia.

This project was part of a larger research effort into information services (EVASERVE). EVASERVE is coordinated and managed by VTT Technical Research Centre of Finland.

ISBN
978-951-38-6627-3 (URL: http://www.vtt.fi/publications/index.jsp)

Series title and ISSN		Project number
VTT Working Papers 1459-7683 (URL: http://www.vtt.fi/publications/index.jsp)		3403
Date August 2007	Language English	Pages 51 p. + app. 2 p.
Name of project Case Croatia	Commissioned by FINNFUND Finnish for Industrial Cooperation Ltd	
Keywords Croatia, meteorology, hydrology, strategy, services	Publisher VTT Technical Research Centre of Finland P.O. Box 1000, FI-02044 VTT, Finland Phone internat. +358 20 722 4404 Fax +358 20 722 4374	

Preface

This study outlines the strategic development plan for DHMZ (Croatian Meteorological and Hydrological Service). The outline begins with current state analysis and identifies priority service development needs. The results of this study are meant to be utilised in the rationalisation of operation and enhancement of DHMZ's services. This study also aims to lay the groundwork for changes conforming to the institutional, legislative and technical framework of hydro-meteorological services required by EU membership and the Single Market.

The study was funded by the FINNFUND Finnish for Industrial Cooperation Ltd and VTT Technical Research Centre of Finland. The analysis work and reporting was performed by M.Sc. (meteorology) Martti Mäkelä from Impact Consulting Oy Ltd and Senior Research Scientists Pekka Leviäkangas and Raine Hautala from VTT. DHMZ management made significant contributions to the study. This group comprised Director General Ivan Čačić, Directors Vlasta Tutiš, Nino Radetic, Branka Ivančan-Picek and Krešo Pandžić, and many others.

The quality assurance for this publication was done by Customer Manager Marja Rosenberg from VTT Technical Research Centre of Finland.

This report represents the views of independent VTT researchers only, and not those of any participating organisations.

VTT Technical Research Centre of Finland, Espoo, June 29, 2007

Pekka Leviäkangas *Raine Hautala*

Contents

Abbreviations

AWS	Automatic Weather Station
CAA	Civil Aviation Administration
DHMZ	Drzavni HidroMeteorologiski Zavod, Croatian Meteorological and Hydrological Service
DP	Data Processing
ECMWF	European Centre for Medium-range Weather Forecasts
ESA	European Space Agency
EVASERVE	Evaluation tool for information services
GPRS	General Packed Radio Service
GSM	Global System for Mobile communications
HR	Human Resources
HRK	Kuna, Croatian currency, about 0.17 euro
ICAO	International Civil Aviation Organisation
IT	Information Technology
MHRK	Million kunas
PR	Public Relations
VPN	Virtual Private Network
VTT	VTT Technical Research Centre of Finland
WMO	World Meteorological Organization

Executive summary

A. Introduction

This publication contains the strategic development plan for the Croatian hydro-meteorological services. DHMZ is a state organisation responsible for the services – it is also the main beneficiary of this plan. The development strategy contains the following elements:

- Vision for 2020
- Strategies until 2010 supporting and targeting the vision
- Action plans that implement the strategies.

These elements are handled in sections, which also form the structure of this publication:

- Observation network and infrastructure
- Information technology, IT architecture
- Production process
- Organisational structure
- Human resources and capacities
- Premises, physical facilities
- Economy, budgeting and finance.

B. User needs

There are two approaches when addressing the needs of users:

- To ask what the needs are, then make an effort to satisfy them
- To create preconditions for an effective production process and ask later what the users need; then the end products (not the whole production process) are specified according to the users' requirements.

These approaches can and should be applied simultaneously.

In the following, the latter approach (i.e. preconditions) is given more emphasis since the short missions to Croatia did not allow comprehensive analysis of users' needs. It should be stressed that analysis of user needs is a laborious task, and very often the users do not have a clear perception of what their business really needs now, let alone in the future. The needs list easily becomes unrealistic with little, if any, willingness to pay for the improved services.

C. Legal basis of DHMZ

The legislation concerning DHMZ is outdated and will be amended in the near future. There are some critical issues that should be reformulated or changed:

i) Hail suppression

This activity is not mentioned in the existing law, but is one of DHMZ's duties for historical reasons. It is not particularly well suited to the modern corporate image of a meteorological institute. Hail suppression should be reorganised under some other organisation, if considered necessary at all.

ii) Civil aviation

This is not a legislation issue directly, but serious consideration should be given to meteorological services for civil aviation being part of the services provided by DHMZ. Considerable synergies in terms of infrastructure and human resources are lost if services for civil aviation are kept separate.

iii) Services for the military

The services provided for the military, including the air force and the navy, belong to the same category as civil aviation, but these services could be included in the law as they represent critical aspects of national security.

iv) Budgeting, finance

In the future DHMZ will most probably operate on a non-profit basis for the benefit of its customers and the general public. However, the administrational budget process could be streamlined if DHMZ collected revenues from commercial services directly from the customers. This would also result in the budget funds from the government being kept at the present level in real terms, while ensuring adequate funds for the development of services and minor investments.

D. Organisational issues

D.1 Observation networks /1/

The suggestions and recommendations made in the recently published report on the Croatian climate observation system /2/ have been taken into account. The centralisation of different observation systems should also be considered.

The maintenance of DHMZ observation stations should be reorganised into one department in order to achieve a scale of economies in maintenance activities.

Automation of the observation network should be a continuous process in pace with the natural wastage of personnel.

D.2 Functions and services

Configuration of the organisation could be simpler, for example:

- Division of services, e.g.
  - Weather
  - Climatology
  - Hydrology
  - Maritime
- Division of research (same as above)
- Technical services and support (maintenance of observation stations, IT, data processing, etc.).

There should be two departments in addition to those mentioned above:

- Director's staff including e.g. a team for PR and editing of an internal newsletter (3–4 persons) + a team for international affairs (1–2 persons) + a chief of staff (1 person)
- Department of administration (could also be a division); human resources management, accounting & finance, internal control; internal control could also belong to the director's staff.

The role of a regional centre in Split is not dealt with in this publication and should be addressed separately. In principle, overlapping mandates and responsibilities should be avoided, meaning that the regional centre should be organised according to the division described above.

E. New premises

One crucial prerequisite for successful operation is to have new premises for DHMZ. It is essential to have all the relevant functions under the same roof. This will improve co-operation, create synergies and make it easier for the staff to understand each other, each other's duties and to exchange information spontaneously.

F. Preparing for competition

Once Croatia becomes a full member of the EU, if not before, there will be competition for services that are not attributed to DHMZ by law. The organisation must be ready to compete with private companies and international organisations in terms of both quality

and costs. Agility in reacting to changing needs, automated processes and cost effectiveness will be key success factors. Even if a commercial unit or services are never established within the institute, the success factors remain the same.

G. Action plan 2010

G.1 Overall meteorological service system and architecture

In order to achieve a level of modern meteorological service, automation should be started by introducing an editing technique.

It is also recommended that a service architecture is created in cooperation with e.g. a close twinning partner and of course in accordance with the international met-service community.

G.2 Investments

Three new weather radars are needed and upgrading of the existing observation infrastructure is necessary. Furthermore, the following investments are recommended:

- A lightning detection network
- Gradual automation of the conventional observation network (part of it can be funded through the normal budget)
- Instrumentation of some radio masts, especially if services for aviation are included in the services repertoire.

G.3 Training and skill building

One of the main issues is to shift the educational structure so that a higher academic level becomes predominant within the organisation. This should be considered every single time a post becomes vacant and recruitment is considered.

G.4 Organisational re-engineering

The process of reorganisation should start immediately. As always, there are many options on how to proceed and organise the re-engineering work, but a compact, effective and cooperative organisational system should be the ultimate goal. The suggested structure provides a framework for such a system. The re-engineering should be made into a project with a high-calibre manager, project team, resources, schedule with milestones and an executive monitoring/steering group. When this project is decommissioned, the new organisation should be up and running.

G.5 Implementation strategies and milestones

An essential part of the implementation strategy is the new law concerning DHMZ. The law has been drafted and could come into force by the end of 2007. It sets the framework within which DHMZ operates.

Other focal issues are the following:

- Utilisation of revenues from commercial customers
- Continuation/discontinuation of hail suppression activities
- New premises by 2010
- Reorganisation
- Educational structure of the staff.

Many of these are continuous processes, but concrete milestones are necessary in order to assert the development work. The detailed planning and execution must be done by DHMZ itself.

G.6 Funding needs

Figures on how DHMZ's functions could be financed in the future are shown in Chapter 5.8 (Economy). The critical items are:

- Lending from international financing sources, such as the European Investment Bank, the Nordic Investment Bank or the World Bank, as well as contributions from the EU's structural funds; major investments need external investment capital from capital providers with a reasonable cost of financing
- Revenues from commercial services; these revenues should be available for DHMZ without having to circulate them through the state treasury
- Outsourcing of some functions, e.g. maintenance and IT; only carefully selected functions could be outsourced and certainly not "everything at once"
- Dismantling of some functions, e.g. hail suppression
- Including services for aviation in order to create economies of scale and save on total costs to society
- Updating salary levels of academic personnel to ensure successful competition for the best talent
- Sufficiency of funds to cover operating costs; the conventional state budget should ensure the covering of operating costs.

Table. Marginal impacts of measures until 2010. + means savings or increased revenue and – means cash outflow for investments or additional costs; figures in million HKR and €. (Figures are in current prices: 1.3.2007, European Central Bank, Euro foreign exchange reference rate, http://www.ecb.int/stats/exchange/eurofxref/html/index.en.html.)

Year	**Organisational changes**		**Operational changes & market orientation**						**Investments & other additional expenditures**							
	Hail suppression removal		Automation		New commercial customers [1]		Services to aviation		Radars		AWs		Lightning detection		New premises [2]	
	million		million		million		million		million		million		million		million	
	HKR	€	HKR	€	HKR	€	HKR	€	HKR	€	HKR	€	HKR	€	HKR	€
2007											-0.7	-0.10				
2008			-0.7	-1.0	1.0	0.14			-7.0	-0.95	-0.7	-0.10			-1.0	-0.14
2009 [3]	75	10.22			2.0	0.27	9.0	1.23			-0.8	-0.11	-1.4	-0.19		
2010			-0.7	-1.0	3.0	0.41	9.0	1.23	-7.0	-0.95	-0.8	-0.11	-1.4	-0.19	-1.0	-0.14
Total 2007–2010	75	10.22	-1.4	-0.19	6.0	0.82	18.0	2.45	-14	-1.91	-3.0	-0.41	-1.4	-0.19	-1.0	-0.14

[1] Assumed 1.0 MHKR increase per year in medium term.

[2] Furniture, office equipment and hardware etc.

[3] Savings of the hail suppression removal are actually over 25 million HKR per year.

1. Introduction

1.1 Background

Croatia is developing its institutional architecture as it proceeds towards joining the European community. Both public and private services need technical, organisational and legal frameworks that enable their production and efficient distribution to various in-need stakeholders. Meteorological and hydrological information services are one such category that needs urgent boosting in order to enhance the socio-economic development of Croatia. Industries such as transport, construction, energy production and agriculture need weather-related information for planning, execution and monitoring of operations.

The results of this Strategic Development Plan are meant to be utilised in the rationalisation of Croatian meteorological and hydrological services. DHMZ (Croatian Meteorological and Hydrological Service) is the state organisation responsible for the services and is the main beneficiary of this plan. This publication was produced by VTT Technical Research Centre of Finland as part of a larger research effort, EVASERVE and related projects, which aims at enhancement of information services in general.

Related to this publication, an approximate cost-benefit analysis has been drafted to show the size of benefits generated by the meteorological services in Croatia (reference). The benefit analysis report was drafted in accordance with this publication and is an essential supplement to it, although editorially separated as an independent report.

1.2 Objectives and method

The objective is to study on an aggregate level what kind of system providing meteorological and hydrological information services is needed in Croatia. The Strategic Development Plan contains the following elements:

- Vision for 2020
- Strategies until 2010 supporting and targeting the vision
- Action plans that implement the strategies.

These elements are handled in sections, which also form the structure of this publication, as follows:

- Observation network and infrastructure
- Information technology and IT architecture
- Production process
- Organisational structure

– Human resources and capacities
– Premises, physical facilities
– Economy, budgeting and finance.

The working process for the development strategy has included fact-finding missions, workshops and correspondence exchanging information (Figure 1). The missions and workshops are listed in Appendix 1.

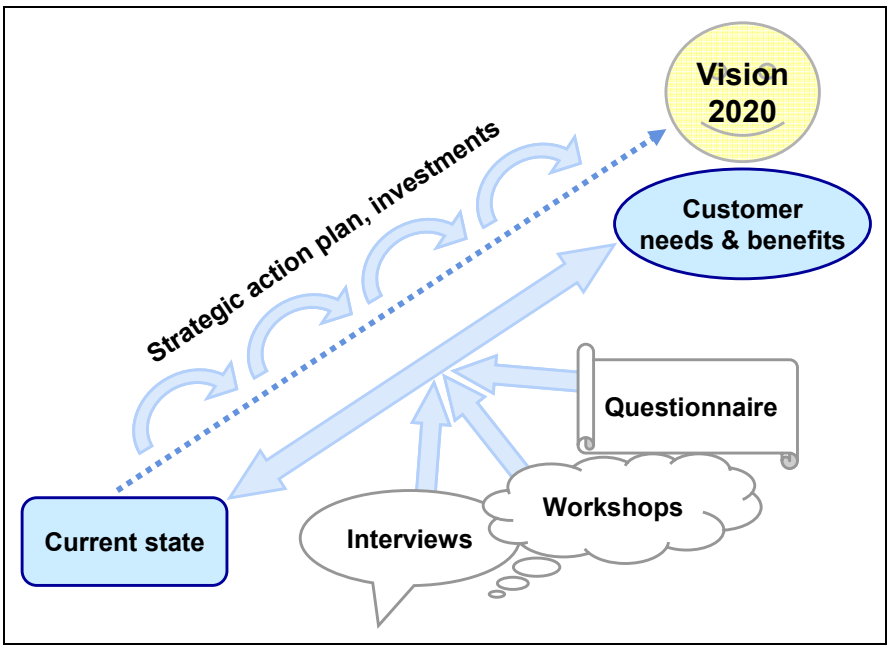

Figure 1. Strategy process.

2. Current infrastructure, organisation and service architecture

2.1 Observations

The current observation network fulfils the requirements of WMO. The following table shows the observation network of DHMZ:

Type of station	*Number of stations*[1]
Atmospheric domain	
Surface meteorological stations	40
Climatological stations	114
Precipitation stations	337
Automatic meteorological stations	58
Radiosonde stations	2
Pilot balloon station	1
Radar stations	3 + 5
Atmospheric composition (pollution) stations	50
Oceanic domain	
Ship meteorological observations	15 + 60
Coastal observation stations (depending on the parameters)	7 + 21
In-situ measurements (automated)	2 + 1
Terrestial domain	
Hydrological observations (depending on the parameters)	100 + 500
Snow stations	483
Soil observations (depending on the parameters)	21 + 57

Additionally, there are more than 400 stations run by other organizations[2].

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1 In case of two figures, e.g. x + y, the first (x) indicates the number of stations that can deal with a more or less complete set of parameters; the second figure (y) indicates the number of stations where only a limited number of parameters are measured.

2 Includes other observers' stations, such as those of the highway authority, power plants, oceanographic institutes, etc.

2.2 Information technology and data processing

The configuration of the existing IT and data processing system is presented in Figure 2. Very similar systems are being used in many meteorological services and the overall architecture works without any significant problems. The main bottleneck is in the production process, for the following reasons:

– Production sites in Zagreb and Split are not open 24 h.

– Every user must be satisfied with manually tailor-made products, i.e. there is a lack of automation.

– The models used (Aladin and ECMWF) and programs used in visualisation (grads, Metview and Trivis) do not have interfaces or middleware that allow products to be combined into one view.

– Much of the work is done with one computer only, and there is no database as such that allows distributed work to take place.

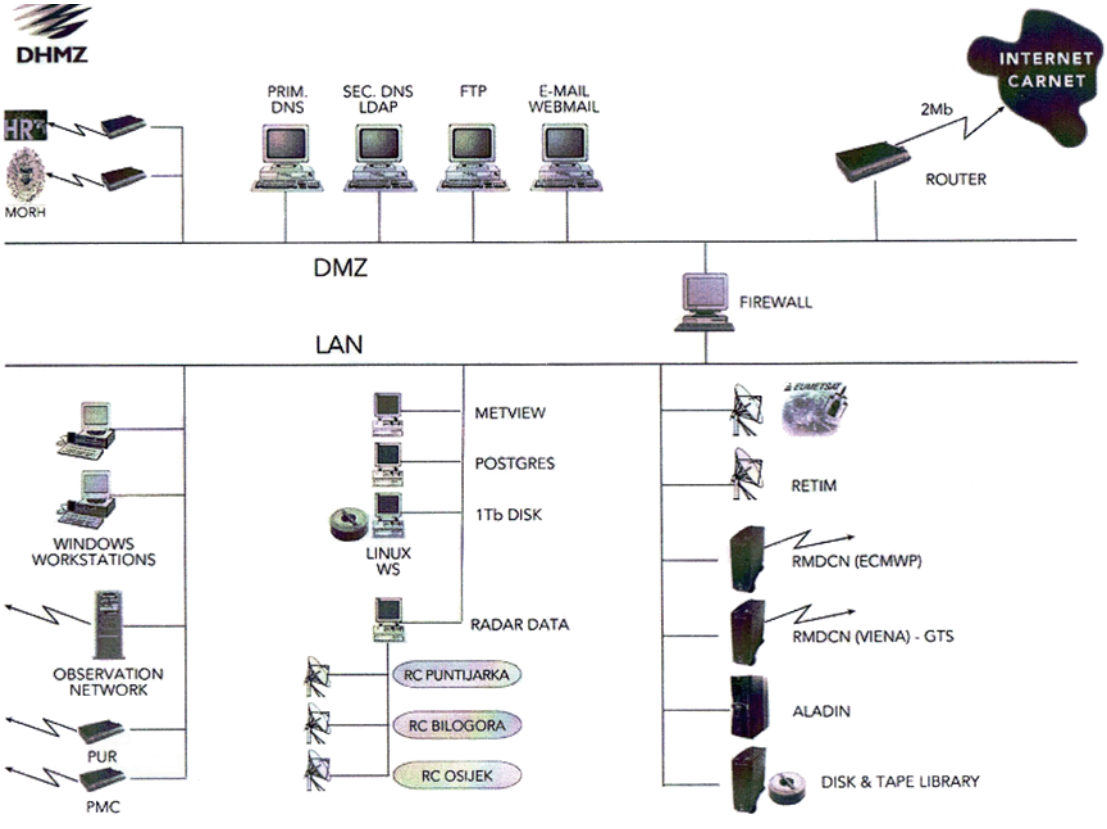

Figure 2. IT architecture of DHMZ.

2.3 Organisation

The existing organisation is outlined in Figure 3. It is divided into five divisions and three separate departments.

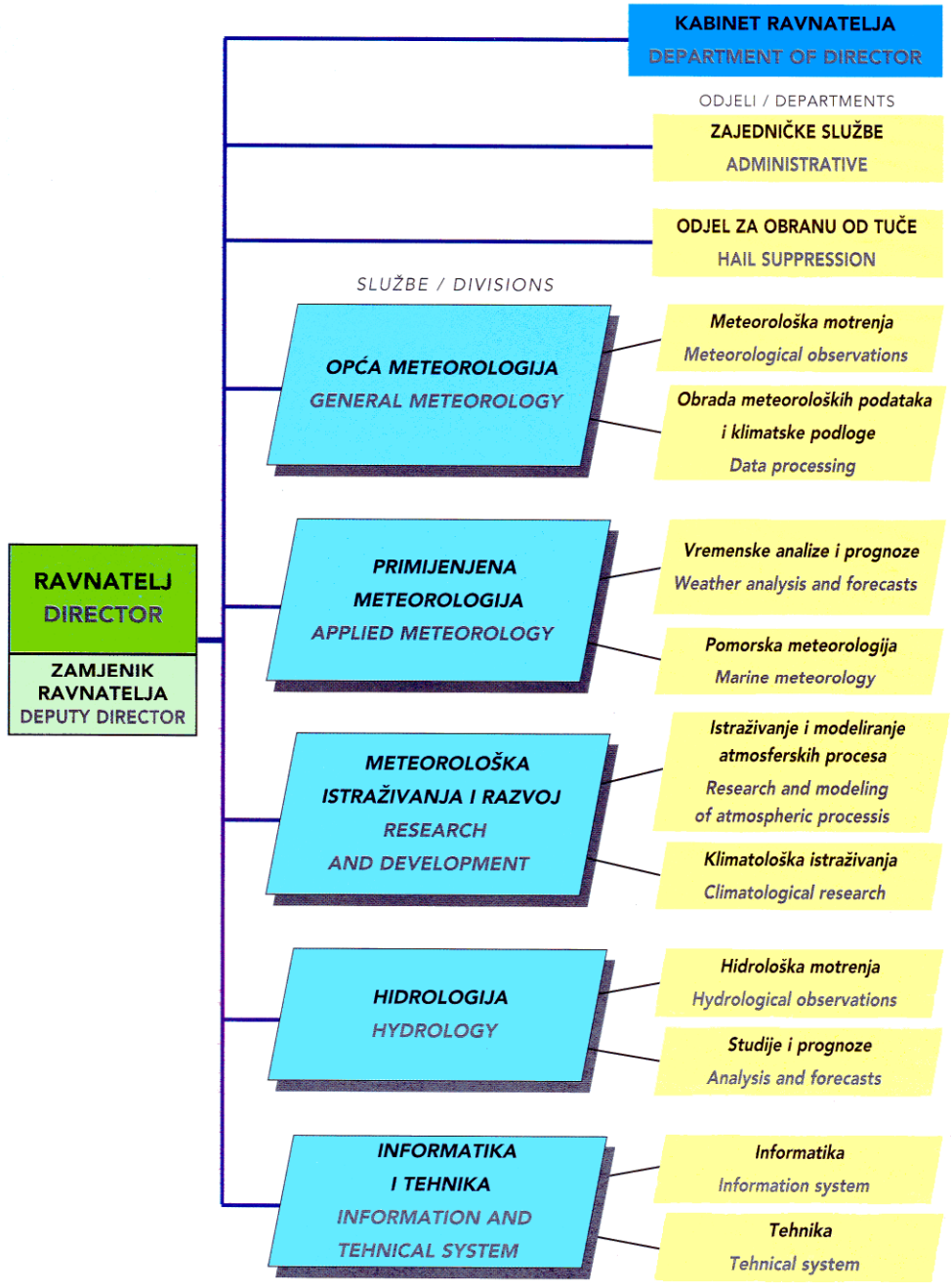

Figure 3. Current organisation of DHMZ.

2.4 Personnel

The total number of DHMZ staff is 456, divided between departments as follows /3/:

Department of the Director	1 + 6
Administration	29
Hail suppression	86
General meteorology	
Observations	122
Data processing	18
Applied meteorology	
Analysis and forecasts	25
Marine meteorology	28
Research and development	
Numerical models and atmospheric processes	16
Climatology	16
Hydrology	43
Information and technical system	
Information	21
Technical system	45
TOTAL	456

Qualification of staff according to educational background:

Primary or secondary school	17%
High school	54%
College degree	7%
University degree	16%
M.Sc. degree	4%
D.Sc. degree	2%
TOTAL	100%

2.5 Premises (in Zagreb only)

Headquarters

Currently, DHMZ works in an old building (more than 150 years) in which renovation activities are strictly restricted. It is inconvenient, non-functional and lacks basic supporting facilities (parking lots, negotiation rooms, coffee break rooms, etc.). The technical sub-systems (heating, ventilation, water, plumbing, etc.) are wholly outdated. Office space is about 1 880 m^2. The total headquarters staff is about 200. The space per

employee is about 10 m^2, which is far too little. There is serious structural damage posing a safety risk for employees[3].

Hydrology division

The division operates in a separate building roughly 0.5 km from HQ. This building too is quite old. The office space is about 450 m^2 with a staff of just under 50. Also here the space available per employee is well under the typical western standard of 15–20 m^2 per person.

2.6 Economy

DHMZ is a state agency which receives most of its financing through the state budget. About 15% of the income is received from commercial services, i.e. from paying customers. The investments are mainly financed with supplementary budgets.

The 2005 budget of DHMZ was 82 million HRK (about 12 million EUR). The annual increase of the budget has been 6–8% in recent years. The total revenue from commercial customers is about 12 million HRK per annum.

Hail suppression takes 13 million HRK from the whole budget and this figure covers only the salaries of hail suppression activities (excluding the overhead plus other pooled costs). Thus the share of hail suppression is quite large.

DHMZ does not have to pay rent for the premises.

The salaries are low compared to the private sector, making it difficult to hire new qualified personnel.

3 This conclusion is based on a brief *in situ* visit by VTT's construction and facilities expert.

3. User needs

When discussing needs, it must be emphasised that the quality of service has to be clearly defined and guaranteed. The quality should be continuously monitored and validated according to agreed procedure accepted by both parties. The needs of users and stakeholders are presented here from three perspectives:

- Activities or functions that are weather sensitive; these include e.g. sea faring, road transport, energy production and so forth
- Phenomena affecting these activities or functions, e.g. bora winds, snowstorms, heavy rainfall, etc.
- Means (channel) by which the information (service) concerning the phenomena is provided; typically these include analogue/digital audiovisual media (radio, TV), Internet, printed media and personal devices (PDAs, mobile phones, etc.).

3.1 The international community

World Meteorological Organization (WMO) /4/, /5/

DHMZ belongs to WMO and has created an active role in that community, particularly as a regional representative member.

Wind warnings

Countries with sea areas are obliged to provide wind warnings in order to avoid hazards at sea. The observations and forecasts are renewed a minimum of four times in 24 hours and distributed by radio.

World Weather Watch (WWW)

The countries that belong to the meteorological community through WMO are committed to provide observation data to other member states. WMO makes recommendations concerning the density of the observation network as well as the frequency of observations.

International Civil Aviation Organization (ICAO)

DHMZ does not provide these services at the moment. Provision of meteorological services for civil aviation is defined in Meteorological Services for International Air Navigation /6/.

Other organisations

There are some organisations, like the European Centre for Medium-range Weather Forecasts (ECMWF) and the European Space Agency (ESA) (satellite images), to which the membership fee is the only compulsory contribution from member states.

3.2 The state and the general public

The needs of the state are based on population safety and security aspects and on statistics for multiple purposes. Safety is secured by warnings, which by law or agreements can be imposed as a duty of the national meteorological services. In Croatia's case, the only official warnings are wind warnings at sea. The channel of distribution is mainly radio.

There are a number of voluntary warnings that are given to other authorities or directly to the general public. These include:

- Inland storms
- Heavy snowfalls
- Thunderstorms
- Heavy rains
- Extreme temperatures
- Slippery roads
- Forest fires
- Accumulation of ice on constructions
- Hail showers
- Landslides
- Avalanches
- Environmental conditions affecting peoples' health.

Two or three of these phenomena often occur simultaneously and thus increase the risks. The information is given using all existing media. The need for real-time information is becoming increasingly important.

The needs of the general public are based on safety, leisure time or convenience factors. All meteorological parameters and means of communication are included in the information.

3.3 Agriculture

Weather-prone activities in agriculture are:

- Irrigation
- Spraying of plants against insects and diseases

- Protection against hail
- Frost protection.

For the purpose of optimising the timing of activities, the following parameters are needed:

- Duration of dry spells
- Evaporation
- Development of hail clouds
- Accumulation of precipitation
- Occurrence of heavy rainfalls
- Maximum and minimum temperatures
- Minimum temperature on the ground.

The service system should be developed in close cooperation with the Ministry of Agriculture and related agencies and organisations (e.g. farmers' association or similar). It is important that the service is flexible in terms of timing and distribution. Therefore, the service should be based on mobile phones and the Internet.

3.4 Traffic and transportation

Maritime

At sea safety must always come first. Therefore accurate forecasts of wind and visibility are vital. In addition, some oceanographic observations and prognoses are needed.

The following parameters are essential:

- Wind speed and direction
- Wind forecasts including local wind, e.g. bora wind
- Thunderstorms with gusts
- Visibility
- Wave heights
- Water levels.

DHMZ provides basic meteorological services for shipping in Croatian sea areas. In addition to the general and maritime forecasts (shipping forecasts), a warning service is provided. The main customers of these meteorological services include:

- Shipping companies, their vessels and the shipping industry in general
- Search and Rescue (SAR) organisations
- Pollution mitigation at sea (oil combating etc.)
- Fishing and fisheries
- Marinas, boating and other recreational use of sea
- Other maritime related actors

Based on contracts DHMZ provides also special meteorological services. These services are today provided as

- marine meteorological bulletins and warnings for ports and anchoring sites
- weather reports and consultations to ships
- marine meteorological bulletins and warnings for
  - shipyards,
  - transport of dangerous and other special cargo by sea and
  - marine maintenance and exploration.

The main development aims specifically related to DHMZ's services to maritime industry are to enlarge the coverage area of services at the Mediterranean and to divide the Croatian coastal waters areas to smaller forecast areas where more local, accurate forecasts are provided.

Air

The users of the meteorological services are:

- Commercial civil aviation (airline operators – even one-man helicopter services, airports and pilots)
- Military air force
- Leisuretime activities (private civil aviation, gliding, balloons, etc.).

These services are not included in DHMZ's services, but it is recommended that DHMZ makes an effort to act as service provider in this market and host the related observation systems and infrastructure.

The services for civil aviation are specified in ICAO's *Meteorological Services for International Air Navigation* /6/. The specifications are compulsory for every service provider.

Other services depend mainly on customers' willingness to pay. Their motivation is that they can gain savings when outsourcing the services to DHMZ, which is still a state institute and thus neutral in pricing services and regarding security aspects. Evidently economies of scale are reachable here.

As to channels, oral briefing, computerised techniques and self-briefing systems are widely used by the military.

Roads

The users are the road authority, transport companies and private road users (general public). The road authority's needs focus on maintenance aspects (snow ploughing, de-icing, etc.) whereas private road users are concerned with safe road conditions.

Transport operators are interested in weather-related information in order to maintain punctuality and keep their schedules. Safety aspects are also present.

The services concentrate on the winter season, especially ploughing and prevention of slipperiness.

The needed parameters are:

- Wind velocity
- Accumulation of snow
- Intensity of snowfall
- Air and surface temperatures.

At present, communication is based on general information released through public media (radio, TV). Communication between authorities should be based on computerised techniques.

Railways

The main problem from the viewpoint of the railways is the accumulation of snow at certain points.

The needed parameters are:

- Intensity of snowfall
- Wind speed and direction (drifting snow)
- Temperature.

Currently, no rail-specific services are provided except for general information through the public media. The information should be given directly to traffic management and other operational centres of railway traffic and track maintenance.

Riverboats

Traffic on the rivers is possible when there is enough water and when the discharge is not too strong.

The users are the state authorities, riverboat operators and private boat owners. The most practical way of communication is the Internet.

The parameters needed are:

- Water level
- Discharge.

Pedestrians

Slippery pavements are dangerous, especially for elderly people. Medical costs incurred by slipping and falling are very high. In some countries, special warnings are issued to pedestrians when the circumstances are particularly difficult. However, such a service is only realistic in the biggest towns and cities. In Croatia these types of warnings are not currently issued.

The needed parameters would be:

- Air and pavement surface temperatures
- Pavement surface conditions.

3.5 Construction

Services for building construction are important during wintertime. For other types of infrastructure construction (water, roads, civil engineering), summertime weather is more essential. The users are state organisations that plan and manage the projects and construction companies that carry them out.

The needed parameters in winter are:

- Temperature
- Wind
- Heavy precipitation
- Accumulation of snow.

In summer, the following parameters are required:

- Thunderstorms
- Heavy rain
- Accumulation of rain.

Currently DHMZ does not offer dedicated services to the construction industry. The service should be provided directly to the end users (e.g. to the management of large projects and construction sites) using the following alternative (or overlapping) channels:

- Internet
- Personal mobile devices.

3.6 Energy production

The needs for energy production vary from seasonal forecasts to forecasts of ice formation on electricity towers.

The users are mostly state-owned companies in various sectors of energy production.

The service products are:

- Seasonal forecasts of temperature and rain
- Warm and cold spells
- Discharge into rivers
- Ice formation, especially with strong wind.

3.7 Air quality services

Air quality services are undergoing continual development worldwide as new requirements and user needs emerge. The development of dispersion models for traffic, industry and nuclear power plants is essential to secure the safety of the population.

DHMZ has issued a good report on air quality services /7/.

3.8 Hydrological services

The hydrological services can be divided into two categories:

- Statistics based on reliable observations
- Daily or real-time services.

Today, the requirements of the first category are met well enough, but the latter category needs improvement especially for water management.

The users are state organisations and private companies in the field of water energy production and distribution, civil protection, inland water transport and civil engineering.

The parameters needed are as follows:

- Precipitation
- Ground water levels
- Evaporation
- Water levels
- Discharge.

In addition, there is a need for water level modelling (floods) which is not available at the moment. The information should be distributed by point-to-point circuit using e.g. restricted Internet platforms, mobile devices or dedicated radio networks.

3.9 Health

There are some diseases in which a patient's condition deteriorates in unfavourable weather conditions. Traditionally, meteorologists and physicians have had close cooperation in Croatia. No urgent new needs are seen at the moment.

3.10 Tourism

Tourism is of increasing importance to the country's economy. It is a very weather-prone industry and therefore reliable weather services are essential to guarantee satisfied touristic experiences.

The users are travel agencies, hotels, touristic programme organisers and the tourists themselves. All climatological parameters should be included in the service. For the weather service the parameters are the following:

- Wind warnings, especially for sailing
- Medium-range forecasts (temperature and precipitation)
- Daily and real-time services (cloudiness, rain and temperature)
- Snowfall and depth (ski resorts).

The information distribution channels are the Internet and mobile devices.

4. Internal needs of DHMZ and gap analysis

4.1 Observations

4.1.1 The conventional observation network

The conventional network fulfils the requirements of WMO. When updating and maintaining the network the following principles are recommended:

a) No new manned stations should be established.

b) When an observer retires/finishes his/her work, the station should be automated.

c) The maintenance of all types of observation stations should be the responsibility of the same technical personnel.

In general, the level of automation should be increased. The network of automated stations should reach around 100 by 2020. This figure does not include stations run by other organisations (e.g. road weather stations). The renewal rate of automatic stations should at first be five stations per year, rising to about 20 stations per year.

4.1.2 Completion of existing networks

The existing weather radar network is not complete. Three new radars are needed along the Dalmatian coastline and one of the old radars needs to be updated. The government should be convinced of the need and there should be a commitment to a long-term investment programme.

4.1.3 New observation systems

A lightning detection system is missing in the country. Such a system belongs to the capacity of any modern meteorological service organisation.

If the services for aviation are mandated to DHMZ, better knowledge of the lower troposphere is needed at least at Zagreb airport. There are several alternatives for achieving this:

- Acoustic radar, sodar
- Wind profiler
- Instrumentation of existing radio masts, if such are available and instrumentation is permitted.

4.1.4 Coordination of observation systems

There are several agencies running observation networks of their own. It is not necessary or feasible to bring them all under DHMZ's responsibility, but better co-ordination of measurement techniques, availability of measurements and data as well access to databases are surely needed.

DHMZ could take the leading role in standardising different systems run by different organisations. A formal coordination body could be one way of organising the effort.

4.2 Information technology and data processing

As stated earlier, IT and data processing architecture within DHMZ is very similar to corresponding configurations in any other meteorological organisations. The development of the aggregate system should be part of normal routines of the institute. No special investments are required. Modifications are needed concerning the organisation of IT and IT-aided production processes.

As there is no large gap between the existing architecture and the needs, no special steps are required. However, the fast pace development of IT should be recognised in annual purchasing plans, as part of the routine.

4.3 Production process

Even when the automatic production process is in place, the meteorologist always has to guarantee the quality. The service can be run fully automatically, but paying customers also demand human interfacing. Therefore the role of the meteorologist is vital.

How the production process will be improved is explained in Chapter 5.4 (Production process).

4.4 Organisation

The purpose of organisational changes is to ensure DHMZ's competitiveness in the future. The statutes of DHMZ are under preparation and should be formulated so that they do not hamper innovation and incentives for service development.

There are some critical changes in which the government must be involved. These are at least the following:

1. Removing or outsourcing hail suppression from DHMZ
2. Including or insourcing aviation weather services into DHMZ's activities
3. Development of the Split unit into an international centre for maritime services
4. Outsourcing some of the technical support and services (e.g. cleaning, cars, part of the IT services, translation services).

Some decisions can be made independently by DHMZ:

1. Streamlining of the organisation
2. With the exception of hail suppression, DHMZ has no unnecessary functions. In order to improve cooperation between different functions within the organisation, it might be worth considering whether there are grounds for cutting the number of divisions. One solution is presented in Chapter 4.
3. The director's cabinet should be strengthened by portfolios for public relations, internal corporate communication, international affairs and possibly internal control. These could be separate staff functions within the organisation or under a single chief of staff.
4. Considering the size of DHMZ, the number of people working in administration seems to be too high.
5. It is absolutely necessary to have at least one unit where meteorologist(s) work in 24 hour shifts.

4.5 Personnel

The number of personnel is adequate, considering among many other things the size of the country, but skills and capacities and a focus on relevant activities should be emphasised. With some changes it is possible to further rationalise the organisation.

One of the most important goals is to raise the education level of personnel. The suggested changes in the organisation support this goal, but special emphasis must be given to the selection of new staff, career planning and nomination policy. Good and candid relations with the university and student organisations are essential to ensure a competitive edge in the recruitment of talented staff. DHMZ must market its reputation as a good employer with competitive salaries.

Change in the personnel structure is a slow process. Every retirement, resignation and recruitment is to be considered with the above goal in mind.

4.6 Premises

The shortage of premises in Zagreb is serious. DHMZ has started negotiations with the government and a site for new facilities has been identified. The process is proceeding smoothly. Many organisational changes can be carried out while waiting for the move to new premises.

4.7 Economy

To ensure its future competitiveness, DHMZ needs changes to its financing model. The institute is not in a competitive position when hiring new personnel, and the state budget does not raise hopes for a better future. The law concerning DHMZ is under consideration and with it the opportunities of the institute are predefined. It is essential to create flexibility in financing, and to reduce dependence on the state budget while maintaining the necessary basic funding level from it. To put it plainly, the state budget should ensure the continuation of present functions, while external finance from commercial customers (public and private institutions and private consumers) should allow improvements and enhancing of competitiveness in the labour supply and service market.

The following issues should be agreed upon between the government and DHMZ:

1. Income that DHMZ has earned from commercial services remains in its use.
2. A gradual decrease of budget financing is approved.
3. Hail suppression is removed from DHMZ.
4. Services for aviation are included in DHMZ's duties.
5. Some support services (cleaning, maintenance of vehicles etc.) are outsourced.
6. A long-term plan for investments is approved.

The foreseen consequences of the above measures would be:

1. The income of DHMZ would increase immediately by 4 million HKR. Later on it could increase by 2 million HKR/year.
2. Financing from the state budget could be decreased by 2 million HKR/year.
3. Hail suppression costs of 13 million HKR/year (salaries only) would be saved immediately; part of that staff would remain at DHMZ, but the budget would be decreased by some 8 million HKR/year.
4. Income from aviation could be some 10 million HKR/year.

In summary, the above consequences would not need to have a radical impact on the budget – quite the contrary, decreases in administration costs would most likely follow.

Last but not least, these measures would strengthen the capabilities and competitiveness of DHMZ in the future.

If the above-mentioned decisions and commitments are made immediately, the budget of DHMZ would be about 92 million KN for 2008; the state budget contribution would be 68 million HKR, and 24 million HKR would come from commercial services. The number of personnel would be cut by around 40.

5. Action plan

5.1 Scope

The steps needed to meet the needs and fill the gaps are described below. A number of them will have to be approved by the Government. All the recommendations must be specified in consensus within DHMZ (e.g. in working groups) and with the Government. On the other hand, a lot of things at DHMZ are in quite good shape, like research and hydrology. These are not considered in the forthcoming strategies and action plans.

In the following, a vision is set out for each section (technical solutions, human resources, etc.) for 2020, followed by milestones and a strategy implementation plan until 2010.

5.2 Observations

5.2.1 Cornerstone strategies

DHMZ is now in a position where it must modify its observation strategy to survive in the future. The approaching EU membership and rising standard of living accompanied by increased cost levels and liberalisation of the services market (which is where DHMZ must operate) are putting strong pressure on rationalisation of the organisation and its capacities. Technological enablers, together with the costs of manpower, are driving working processes towards automation. Ubiquitous technologies are driving towards real-time, info-pushed and tailored services. These drivers require of the organisations higher education levels, better market understanding and orientation, as well as the agility to react to rapidly changing needs.

The basic principles for organisations to achieve this, especially in the field of information services, are the following:

– Good, quality-assured basic raw data, which in turn requires a solid and well functioning observation/monitoring network

– Capabilities to provide real-time and tailored services relatively quickly; this means that on top of the observation system, a *service system layer* has to be put in place[4]

[4] Here "service system layer" refers to systems capable of combining and refining the observed weather and hydrological data in a cost-efficient manner, as well as distributing the information products to customers in a format they can easily utilise. These systems typically make use of existing state-of-the-art systems which process models, forecasts, etc. which in turn rely on observed raw data.

- Sustaining the motivation of highly educated professionals by offering competitive salaries and incentives, as well as providing inspiring challenges and career opportunities
- Partnerships with key customers; in commercial services the idea is not to offer everything for everybody but to gain trust and credibility with most important long-relationship customers, seen more as partners
- The above-mentioned principles apply also to public service obligations; the society is represented by high-level civil servants and politicians who must have total confidence that DHMZ's services are reliable and well worth the costs paid by the state.

5.2.2 Technical solutions

Vision 2020

About half of the conventional observation network is fully automated. One third of stations are semi-automatic, with only some observations being made by human intervention. The remaining observations are still made manually.

Croatia has a complete radar network (five radars) that is also able to serve neighbouring countries.

Observations at airports are made by CAA personnel manually, if ICAO has not changed its strategy concerning the reliability of the observations. DHMZ has direct access to this data, both real-time and historical.

All new detection technologies, like lightning detection, are widely used, and equipment is well maintained through reliable after-sales service contracts or by DHMZ itself.

All hydro-meteorological observations made by other organisations are coordinated by DHMZ, and DHMZ has access to all observations.

Milestone 2010

The long-term plan should be put into practice on a yearly basis, taking into account the existing funds and technical feasibility. On average this means automation of about five stations per year, installation of two new radars (2008 and 2010) and procurement of a lighting detection system.

5.2.3 Human resources

Vision 2020

The number of civil servant observers has decreased by about 150 (50 in the basic network and 100 in secondary stations). There are some 600 voluntary observers, compared with 1 200 at the moment. The number of well-trained technicians has risen by about 10.

Milestone 2010

The number of personnel involved in observation practice has decreased by 20–25, on average 6–8 persons per year. At the same time, the availability of well-trained technicians for radar and AWS maintenance has been secured.

5.2.4 Strategy implementation plan by 2010

Observation network plan

DHMZ should prepare the plan in which the automation schedule for the conventional observation network is defined. The first years should be strictly defined, leaving flexibility for later years only. The plan should be subject to yearly evaluation.

The radar network will consist of five radars in the future. This means that three new radars will be procured and one old one updated. The installation sites have been more or less defined, but the sequence and a realistic time schedule are essential. In order to avoid technical and funding problems it is suggested that a new installation takes place every 2 years starting from 2008. The first installation should be the site that best completes the existing network. Preparation for the technical configuration can be started immediately.

The shape of the Croatian territory somewhat complicates the implementation of a lightning detection system. The reliability of the observations is not good if the detection points are in a straight line. Therefore, cooperation with Bosnia-Herzegovina is needed. The network consists of four to five detectors.

The last part of the plan is a suggestion of how all hydro-meteorological observations could be utilised in the best possible manner. DHMZ should take a leading role (because it is unlikely that any other organisation will do this) and prepare a master plan covering all organisations and communities now making these observations, on how the activities will be coordinated in the future and for the common good.

Human resources plan

There are two parts in the human resources plan:

- Age structure of the personnel involved in observation activities
- Estimation of their possibilities to be trained for other duties.

The first part includes a list of people who will retire in the next few years and an estimate of how many will resign. The second part is more complicated as it requires face-to-face discussions; it can be very frustrating and stressful for these individuals. On the other hand, opportunities will be created for active and capable individuals.

Plan integration

Finally, the plans (observation network + human resources) must be integrated and the implementation plan for the coming years must be prepared, approved, decided upon and monitored.

5.2.5 Financing and budgeting 2007–2010

Investments

The prices for the above equipment are approximately as follows:

- Basic AWS (temperature, wind, pressure and humidity 150 000 HKR
- Prevailing weather and visibility 70 000–100 000 HKR
- Cloud base 200 000 HKR
- Radar (not including building) 7 000 000 HKR
- Lightning detection/station 700 000 HKR
- Central unit for lightning detection 700 000 HKR

Assuming that five basic AWSs are installed each year, two weather radars are installed in 2008 and 2010 and the lightning detection system is installed in 2009, the investment programme including lightning detection stations abroad would look as follows:

Year	Radars	AWSs	Lightning detection	**Total**
2007		750 000		**750 000**
2008	7 000 000	750 000		**7 750 000**
2009		750 000	1 400 000	**2 150 000**
2010	7 000 000	750 000		**7 750 000**
Total	**14 000 000**	**3 000 000**	**1 400 000**	**18 400 000**

Financing

It is clear that DHMZ is not able to finance the investments through their normal budget. The budget might allow finance of AWSs but not more. Traditionally WMO has arranged loans from different investors, but this procedure requires acceptance by the Croatian Government and the security provided by the Croatian state. This is one feasible option for finance.

Savings

The average yearly salary of an observer (civil servant) is about 50 000 HKR. If automation starts with the basic stations, annual savings would be about 10 person-years. On the other hand, it may increase the investment in prevailing weather sensors (70 000–100 000 HKR/year/station). The savings would then be (without sensor investments):

– 2007	0.5 million HKR
– 2008	1.0 million HKR
– 2009	1.5 million HKR
– 2010	2.0 million HKR
– Total for 2007–2010	**5.0 million HKR**

5.3 Information Technology and Data Processing

5.3.1 Problem set

There are three main problems related to this issue:

1. DHMZ does not have enough experts to carry out all the tasks related to IT and processing of data (DP).
2. DHMZ is not able to compete with salaries paid in the private IT sector.
3. Telecommunications costs are high.

Vision 2020

It is clearly defined which functions of IT and DP are under DHMZ's direct control and which have been outsourced through the competitive process. The best quality-to-price deliverer is selected as a service provider. A quality assurance system for the service is in place.

Milestone 2010

Selected parts of IT support and/or system maintenance have been outsourced and experiences are gathered and evaluated systematically.

5.3.2 Strategy implementation plan by 2010

The process has already been started and a good example is the replacement of expensive telecommunication lines between service centres with a new virtual private network (VPN).

No specific measures are suggested.

5.3.3 Financing and budgeting

No major impacts on budgets and finance are foreseen.

5.4 Production process

5.4.1 Strategy

The set-up

In the future, society, the public, and paying customers will demand better access, reliability, actuality and locality-relevance of data. At present the process does not support these requirements and needs modifications, mainly towards automation. Growing competition is also creating pressure towards automation.

In principle, the meteorologist can intervene in the production process at two points:

- First, by modifying the product (usually a numerical model), or
- By editing parameters produced from weather chart.

The first should be the case in the future. Today, however, the technical capabilities of the meteorologists are sufficient for this process. Hence, automation should focus on editing techniques. In principle, the process is as follows:

- The model produces parameters in geographical grid points.
- Wherever necessary the meteorologist modifies the values.
- The finished grid point presentation is processed automatically into a prognosis, which is delivered to the client automatically.

The editing will be done for the domestic domain only – forecasts abroad will be fully automated.

It would be very important for DHMZ to start making changes towards automated processes in order to fulfil the requirements of customers, and to rationalise its processes, before the competition gets tougher.

Vision 2020

DHMZ is capable of providing tailored services for different users either manually or completely automatically. All the services are available 24 hours through a single contact point.

Milestone 2010

At least in one service location a meteorologist is on duty on a 24/7 basis. Automated services are provided at least via the following media to selected customer sectors:

- Mobile phones; the services are activated by consumers/customers via their personal devices and GSM/GPRS network.
- Internet; the services are either activated by users with restricted access to service sites, or the service is automatically updating static content service with open or restricted access.
- The press; the service products are directly sent to editorial process by push (automatically sent) or pull (actively retrieved by the customer).

5.4.2 Strategy implementation plan by 2010

Means to acquire the automated system

There are three different ways to solve the automation problem, namely:

- Do-it-yourself: This is usually the hard way of automating and leads to tailored (non-compatible) systems; the systems are very much dependent on the persons responsible for the technical work; usually this approach also leads to high fixed costs as these persons must be hired full- or part-time.
- Purchasing the system through a turn-key contract: This way is easier but updating may be costly; no substantial fixed cost risk; usually technical support is reasonably well available but service contracts may be costly.
- A combination of the two: E.g. in cooperation with other meteorological institutes that already have these services in use; probably the way of implementing with lowest incremental cost, but updating and technical support must be ensured already in the procurement phase; offers the best possibilities to gain know-how with no fixed costs.

The work and training of meteorologists

Traditionally meteorologists are conservative when new methods are introduced. The increasing automation and editing process means a major change in the hands-on work of the meteorologist. Therefore it is very important that the users/operators of the system are committed to the development work from the very beginning.

At least at the headquarters a 24/7 service should be available in the very near future. This means an increase in the number of meteorologists and a change in the personnel structure.

5.4.3 Financing and budgeting

A functional production system with basic configuration costs of about 700 000 HKR. It might be possible to include these expenses in the normal budget of DHMZ. The final version, including all services especially for media, would cost about 1.5 million HKR.

The increased salaries of meteorologists could be compensated for from the savings from retired, resigned and reassigned personnel.

5.5 Organisation

5.5.1 The cornerstones

The structure of the organisation should be subject to regular evaluation. DHMZ's organisation is a heritage from before independence and it does not meet the characteristics of a modern research and service institute.

The main problems are the following:

- The structure is incoherent and divided into too many units, causing extra organisational and managerial friction.
- Cooperation between research and services, and between different divisions, is insufficient.
- There are activities that do not belong to a modern meteorological institute, i.e. hail suppression.
- Weather services for aviation are not in DHMZ's mandate.

DHMZ has already proceeded with the preparation of a new organisation structure. However, the draft does not appear to be leading towards the final target. Instead of centralisation and more effective cooperation, the new scheme diverts the units and the processes. If this arrangement is absolutely necessary, it should be a temporary solution.

Vision 2020

The organisation for 2010 is constructed in such a way that good cooperation between units has become everyday routine. Hail suppression no longer belongs to DHMZ's duties. A number of support activities have been outsourced. Services to civil aviation and the air force guarantee a remarkable income for DHMZ.

Milestone 2010

The organisation structure is flat and more centralised/specialised than today, i.e. research under one division and services under another.

Meeting the needs presented in Chapter 4.4 (Organisation) could be solved in different ways. One possible solution is presented in Figure 4. The status of hydrology should be considered carefully. Hydrology can be part of the research division, but it might be feasible to keep it as a separate division at least at the start of the restructuring phase.

The leading principles are streamlining and centralisation/specialisation of activities. At the same time, the cooperation between different personnel groups has been strengthened. For current operational units this suggests the following:

Director's cabinet: The unit will be strengthened as envisaged in Chapter 4.4 (Organisation).

Hail suppression: The unit will be removed from DHMZ.

Administration: Reducing the number of personnel ought to be considered because automation takes place also here.

Division of services: All real-time services are concentrated into one division – "a real-time management/service centre". This means that the meteorologist on shift has access to all hydrological data and has a minimum knowledge of air quality activities. This centre will operate on a 24-hour basis. Division of services could be divided into three departments:

- Hydrometeorological services in Zagreb
- Maritime services in Split
- Product development.

Division of research and development:

The division could comprise five departments:

- Atmospheric processes and modelling
- Climatology
- Hydrology (can be a separate division as well)

– Air quality + laboratory
– Remote sensing (satellites, radars etc.).

Additionally some people might be involved in projects and in oceanography.

Division of support:

The division is divided into three or four departments depending on where the laboratory is situated:

– IT and data processing
– Observations
– Equipment maintenance and calibration.

Observations are divided into three units:

– Conventional observations
– Establishment, maintenance and inspection of stations
– Radar specialists who also are responsible for automatic weather stations.

The other activities in the Technical and Information Division have been outsourced.

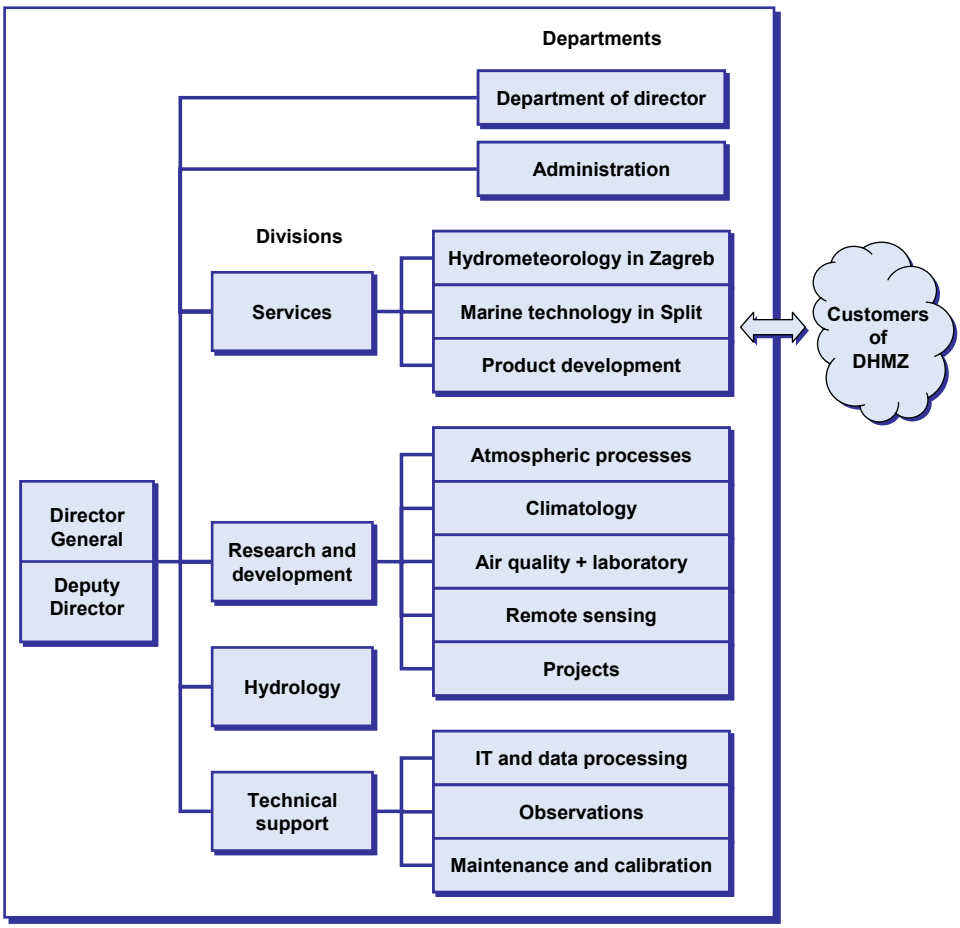

Figure 4. The proposed customer-oriented organisation of DHMZ.

5.5.2 Strategy implementation plan by 2010

The new law concerning DHMZ

DHMZ has an excellent opportunity to feed its views into the content of the new legislation which is under preparation. It is vital that the law does not overly diminish the manoeuvrability of DHMZ, which should be capable of renewing its organisation and work processes as well as its service architecture.

Internal preparation

The new organisation model should be prepared so that it can be launched at the same time as the new premises become available (2009). One prospective organisation model is presented in Figure 4. The new assignments and their descriptions should naturally be prepared before the new organisation comes into force.

External preparation

There are several issues that need Government decisions in order to be realised, namely:

a) Establishment of new vacancies

b) Suppression of old vacancies

c) Mandating outsourcing of certain activities

d) Allowing saved budget funds and revenues from commercial services to be in DHMZ's use

e) Extracting hail suppression from DHMZ

f) Including services for aviation in DHMZ

g) The role of Split as an international service centre.

DHMZ should start negotiations with the Government on these issues.

Arguments for the suggestions are the following:

Points a–c

If DHMZ is not allowed to carry out these changes, its personnel structure will remain as it is and this is totally different from Western European countries. (See Chapter 4.5, Personnel.) In the future, economic pressures will increase for DHMZ. The worst case scenario, which is an unnecessary and unlikely one, is that DHMZ is not able to catch up with the rest of the Western European family.

Point d

It is clear that if the savings earned from automation and suppression of vacancies do not remain in DHMZ's use, points a–c are no longer realistic. Furthermore, the

motivation for rationalisation and improvements in efficiency will be reduced. This in turn will reflect on the work climate and corporate image.

Point e

Hail suppression is a rudiment from earlier days and consumes too much of the scarce resources of any modern meteorological institute. If the activity is considered necessary it ought to be resituated, e.g. under the Ministry of Agriculture. The first and foremost reason why hail suppression should be discontinued is that there is no evidence of its cost-effectiveness and positive impacts. It consumes a very large portion of DHMZ's budget, about 1/4.

Point f

Meteorological services for aviation are divided into two categories:

- Meteorological observations at airports (METARs)
- Services for pilots/airline operators (TAFs, warnings, TRENDs, SWCs, briefing etc.) issued by the meteorologists.

The first are carried out by CAA personnel in most European countries. Observations *in situ* are an economical way to carry out the task, because these persons are posted at the airports anyway.

The second set of services is provided in Europe in at least three different ways: The services are run by meteorological institutes (most European countries), by state-owned organisations (Austria), or by private companies (Baltic states). WMO supports the first option based on the following arguments:

- The meteorological community remains an entity.
- 24-hour + 7-day service is cheaper to arrange.
- The background material is the same – and normally very much better – in all services.
- The meteorologists are equal concerning working conditions and salaries.
- International cooperation is easier and more coherent.
- This solution is the most economic one.

There is also one more point to this: if the need and arguments for additional liberalisation arises later, some or all of the commercial functions of the met-institute can be divested and commercialised or even privatised.

The economic and financial arguments are presented in Chapter 5.8 (Economy) from DHMZ's point of view.

5.5.3 Financing and budgeting

The reorganisation process itself does not have any visible influence on the budget, but the consequences on the revenues and expenditures of DHMZ are dramatic. This point is discussed in Chapter 5.8 (Economy).

5.6 Personnel

5.6.1 The cornerstones

Only 5% of the DHMZ staff has an academic degree. Rapid measures are needed to improve the existing situation. There is also a need for credible career planning for the staff that remains in DHMZ's service.

Vision 2020

The number of employees with civil servant status is slightly reduced from that of today. More than 40% of employees have a university degree. The number of people working in supporting tasks has decreased to marginal.

Milestone 2010

The number of employees with a university degree has doubled. Decreasing the number of supportive tasks has started according to the devised plan.

5.6.2 Strategy implementation plan by 2010

Personnel structure

DHMZ should immediately start to prepare a plan for the new personnel structure. The following items should be presented in the plan:

1. Age distribution (how many will retire)
2. An estimate of how many will resign
3. An estimate of how many new academic vacancies it is possible and necessary to establish in the coming years
4. A clear plan of where the new posts will be situated
5. The impact of automation on the work force (especially observers).

Enhancing the status of the meteorologist

DHMZ has had difficulties hiring new meteorologists because of low salaries and a lack of recognition. DHMZ should make an effort to include the title "meteorologist" in the

government's list of official professions. At the same time, the salary level of meteorologists should be improved.

Training and outsourcing

DHMZ should prepare a training programme – both external and internal (in-house and using external courses/training periods) – in which the institute offers opportunities for their existing staff to improve their professional skills. This could motivate people to search for better posts and avoid being made redundant. Both management training (e.g. eMBA and similar) and professional training (mainly for meteorologists) is vital. The former is offered by many universities and training institutes throughout Europe, and the latter could be arranged e.g. through multi- or bilateral agreements with other met-institutes (e.g. twinning programmes).

All the tasks that do not represent the core expertise of DHMZ should be outsourced.

5.6.3 Financing and budgeting

Personnel restructuring can be financed through internal budget shifts.

5.7 New premises

New premises are already under preparation and no special measures are needed. The new headquarters will be situated by the road to the airport, on the south shore of the river. The space will be approximately 8 000 m^2 and all units in Zagreb will be placed in the same building.

5.8 Economy

5.8.1 The cornerstones

The figures presented below are estimated based on the assumption that the actions described earlier have taken place. The estimates are, of course, directive and inflation has not been accounted for.

Vision 2020

The economy of DHMZ is stable and the annual budget is about 80 million HKR. The contribution from the state is 50–55 million HKR and the revenue from paying customers is 25–30 million HKR. These figures assume elimination of the hail

suppression activity and rationalisation of the work force. In effect, the budget is somewhat increasing.

Milestone 2010

The DHMZ budget is about the same as today, but investments have started as well as the personnel restructuring, meaning that the redundant work force is replaced by university degree personnel with the ratio "two out, one in". Hail suppression is removed from DHMZ.

5.8.2 Strategy implementation plan by 2010

There are four different means to reach the targets:

- Concentration on the core expertise (outsourcing and reorganisation of hail suppression)
- New customers (aviation and others)
- International loans for major investments (radar, lightning detection, automation)
- Income from commercial services should stay in the hands of the institute.

The following actions could be scheduled for the later years:

- 2008: hail suppression removed from DHMZ, one radar, automation of the production process (first phase)
- 2009: outsourcing, lightning detection, new premises, services for aviation
- 2010: one radar, completion of automation of the production.

Additionally, automation of the observation network should proceed as planned in Chapter 5.2.

Restructuring of the personnel structure should be carried out simultaneously.

The annual external income increase could reach the level of 1 million HKR per year excluding prospective income from services to aviation.

5.8.3 Financial plan 2010

The impacts of the suggested measures are shown in Table 1 below. The reduction of redundant personnel is assumed to be offset by new recruitment of university graduates and academic personnel.

Table 1. Marginal impacts of measures until 2010; + means savings or increased revenue and – means cash outflow for investments or additional costs; figures in million HKR.

Year	**Organisational changes**	**Operational changes & market orientation**			**Investments & other additional expenditures**			
	Hail suppression removal	Automation	New commercial customers [1]	Services to aviation	Radars	AWs	Lightning detection	New premises [2]
	million HKR	million HKR			million HKR			
2007						-0.7		
2008		-0.7	1.0		-7.0	-0.7		-1.0
2009 [3]	75		2.0	9.0		-0.8	-1.4	
2010		-0.7	3.0	9.0	-7.0	-0.8	-1.4	-1.0
Total 2007–2010	75	-1.4	6.0	18.0	-14	-3.0	-1.4	-1.0

[1] Assumed 1.0 MHKR increase per year in medium term.

[2] Furniture, office equipment and hardware, etc.

[3] Savings of the hail suppression removal are actually over 25 million HKR per year.

6. Conclusions

The strategic development plan for the Croatian Hydrological and Meteorological Service (DHMZ) follows a "textbook" example of strategic planning. The rationale lies in the fact that the liberalisation of services within the EU will take place and Croatia will be involved in this process. This will result in increasing pressure on former state organisations to re-orient themselves to new conditions characterised by market survival and customer acceptance. The plan is motivated by this European process and was drafted with the goal of increasing the competitiveness and customer-orientation of DHMZ in mind. These motives are free from any other possible interests that might be intertwined with political or economic frameworks and the decisions taking place within them.

VTT has adopted the above-described approach as a neutral and non-profit research organisation. Much of the material and background information was gained from workshops and informal discussions with DHMZ experts and managers as well as with their customers. Hence the results, i.e. the proposals and suggestions for strategic restructuring, should also to a large extent reflect the mindset of the people who participated. However, it should be emphasised that in many respects the actual outcomes in the form of suggested measures, e.g. concerning the organisation structure or personnel restructuring, are the researchers' conclusions, not the results of consultation. Thus this strategic development plan also reflects previous experiences from similar strategic plans drafted by VTT researchers.

DHMZ is in a good position to set out a regional example, or benchmark, of how meteorological and hydrological services can be efficiently modernised and transformed from state institutions to true service organisations. The management capabilities, especially at personal levels, of DHMZ are considered to be high. The risk lies with the possible friction that might result from political processes, conflicting interests and finally, as a result of these, reduced management freedom. Management autonomy up to a certain point is always necessary when carrying out major restructuring.

The transformation process is a hard, consuming road for the whole organisation, both management and employees. Delays and deviations from the plan are more than likely. What is important is that the legal framework supports the transformation and that the change is not halted but continued despite the inevitable hurdles.

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5. Guide of Global Observation System, publication number WMO 488; publisher: WMO.
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7. Phare 2006 Project Fiche; publisher: DHMZ.

Appendix 1: Interviews and workshop representatives

Interviews

DHMZ, Croatian Meteorological and Hydrological Service:

Ivan Cacic, director

Vlasta Tutis, assistant director for applied meteorology

Nino Radetic, assistant director for technics and IT

Kreso Pandzic, assistant director for general meteorology

Janja Milkovic, head of climatological division

Zvonimir Katusin, head of department for climatology

Mario Kresic, head of technical department

Ksenija Cesarec, head of department for studies and analyses

Milan Zupan, head of department for measurement of surface and underground waters

Borivoj Terek, head of division for measurement of surface waters

Ministry of Science, Education and Sports:

Radovan Fuchs, ministerial assistant

Andera Tomljenovic, ministerial assistant

Embassy of Finland:

Ilpo Manninen, ambassador

Laura Stojic, project officer

Participants in the Workshop (Espoo 19.–20.6.2006)

DMZH: Nino Radetic, Kreso Pandzic, Vlasta Tutis, Branka Ivancan-Picek, Dusan Trninic

Croatian Motorways Ltd: Mario Buljevic

Croatian Protection and Rescue Directorate: Maja Matias-Filipovic

Finnish Meteorological Institute: Pekka Plathan, Mats Wiljander, Juha Kilpinen, Ari Venäläinen, Marja-Liisa Ahtiainen

VTT: Raine Hautala, Martti Hekkanen, Pekka Leviäkangas, Jarkko Lehtinen, Lasse Makkonen, Mikael Ohlström, Jukka Räsänen, Sanna Sonninen, Risto Öörni, Jorma Rytkönen, Martti Mäkelä (Impact Consulting Oy Ltd)

Participants in the Workshop (Zagreb 7.–8.11.2006)

DHMZ: Vlasta Tutis, Nino Radetic, Borivoj Terek, Davor Nikolic, Gordana Zuccon

DUZS: Milan Erjavec, Maja Matijas-Filipovic

Croatia National Electricity: Branko Grgic

Finnish Meteorological Institute: Seppo Saku

VTT: Risto Öörni, Jarkko Lehtinen, Martti Mäkelä (Impact Consulting Oy Ltd), Mikael Ohlström, Martti Hekkanen, Pekka Leviäkangas, Raine Hautala, Sanna Sonninen

ISBN 978-951-38-6627-3 (URL: http://www.vtt.fi/publications/index.jsp)
ISSN 1459-7683 (URL: http://www.vtt.fi/publications/index.jsp)