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Co-ordination of Research Policies with the Western Balkan Countries

(Draft of)
National background report on Environment for Croatia

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Contents

1. Purpose of strategic research agenda for Environment

The main objective of this document is to provide a summary of research activities in the field of environment in the Republic of Croatia along with a SWOT analysis of research capacities and identification of research priorities in order to facilitate the interaction between the WBCs and the EU member states in the area of science and technology.

The consultation process started in March 2009. The key stages in the consultation process were data collection that includes surveys of stakeholders by interview or questionnaire and data review and analysis.

However, due to the complexity of the scientific issues involved and due to the difficulties in scheduling the face-to-face discussion and exchange of views among all stakeholders, this overview is by no means overarching and complete. Thus, for determining a final set of research priorities in the field of environment, a larger number of stakeholders need to be involved in the process.

This report was prepared by Dr. Slaven Dobrović, Assistant Professor at the Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb.

2. The Environment S&T system in Croatia

The current state of the environment

Croatia has a relatively well-preserved environment compared to the situation in the EU, mainly due to the relatively low level of heavy industrial production over the past decades and its correspondingly low detrimental impact on the environment. It is distinguished by a great biological and geographical diversity and it has relatively abundant fresh water supplies. However, investments in the environment sector and the level of environmental protection are lower than in developed European countries. That especially relates to the solid waste and wastewater management, along with the establishment and maintenance of a sustainable water supply system[1].

Municipal waste presents a significant environmental problem in Croatia. In 2005, municipal waste production per capita is estimated at 327 kg/person/year. Further increase in municipal waste generation is expected due to continuous economic growth, tourism development and increase in general consumption. Landfilling of unseparated/mixed municipal waste continues to be the dominant waste management method in Croatia. Croatia has a high potential for recycling since a large proportion of the waste currently going to the landfills is actually recyclable (approximately 2% of total municipal waste generated was collected separately and recovered, 1% was composted, and 79% was disposed at landfills[2]). It is assessed that 66.5% of municipal waste refers to biodegradable waste.
In relation to the separation and recycling of waste, the state has been improved by adoption of new legislation for management of specific waste stream (packaging waste, waste tyres,

[1] Strategic Coherence Framework 2007-2013, Instrument for Pre-accession Assistance, Republic of Croatia, Central Office for Development Strategy and Coordination of EU Funds
[2] Indicator Fact Sheet – Theme WASTE, Croatian Environment Agency

waste oil, end-of-life vehicles, waste batteries and accumulators) in compliance with EU requirements and beginning of their implementation in 2006.
Little more than 50% of non-hazardous industrial waste generated is sent to licensed landfills or separated. Almost the same amount of waste is deposited in illegal dumpsites which are assessed at 3000. There are 281 controlled municipal waste landfills with an active capacity of 69,402,670 m^3. However, only 25 are totally in compliance with relevant plans/legal provisions and have all necessary permits and they constitute only 37% of this active capacity. The state has been significantly improved by remediation and closure of 229 municipal landfills initiated in 2004 and co-financed by the Environmental Protection and Energy Efficiency Fund (EPEEF). There is also an ongoing process of a gradual remediation of illegal dumpsites and sites highly polluted by waste (hot spots).

According to the UN FAO database the renewable resources of freshwater per capita amount to 23.8 m^3, indicating relatively high quantities of good quality fresh water. Approximately 76% of population has access to the public water supply system but this varies considerably from one location to another. Moreover, there is a growing seasonal demand for water in coastal area and islands during the hot summer months and tourism peaks.
The main source of public water supply is groundwater (about 90%). Drinking water supply sources are protected through legally defined zones of sanitary protection. Due to age and lack of network maintenance the system has become very permeable resulting in losses of around 46% of the total abstracted water.
In addition, the presence of pharmaceutical compounds and personal care products currently found in municipal wastewaters indicates poor wastewater management practices and thus the environmental fate of these compounds in natural waters is attracting increasing attention[3].

Only 12% of wastewater is treated and only 4.4% of the total wastewaters are subject to biological treatment in 82 wastewater treatment plants (WWTP). Concerning industrial wastewater, around 20% is being treated in independent industrial WWTPs and then discharged. Of this quantity, around 50% is discharged into a public sewer after preliminary treatment and 30% is discharged directly with little or no pre-treatment.
Moreover, it is estimated that only 40% of the population is connected to the public sewage network, whose length is approximately 6 000 km. The levels of connection to sewerage systems are in overall quite low, and they vary significantly depending on the size of settlement.

2.1 The Croatian Environmental policy framework

This section will provide the overall policy framework pertinent to environmental research in the Republic of Croatia and present the main elements of environmental research policy making.

2.1.1 The overall policy framework

The Constitution of the Republic of Croatia determines that "conservation of nature and the environment…are the highest values of the constitutional order of the Republic of Croatia and

[3] Terzic et al., 2008. Occurrence and fate of emerging wastewater contaminants in Western Balkan Region. Science of the Total Environment **399**(1-3): 66-77.

the ground for interpretation of the Constitution" (Article 3). Furthermore, the Constitution emphasizes the right to a healthy environment and the commitment to the protection of human health, nature and the human environment (Article 69).
Environmental protection requirements must be integrated into all relevant sectoral policy areas (transport, energy, agriculture, tourism, etc.). Hence, environmental protection should be an integral part of transport infrastructure development, as well as of energy, agriculture, and industrial development. Besides the preservation of the biological and geographical diversity, the Adriatic seacoast and islands and the corresponding municipal infrastructure, such as water supply, sewage and waste water treatment infrastructure and waste infrastructure, are preconditions for the long term development.

The national environmental policy framework in Croatia includes:

- Strategic Development Framework 2006-2013 (SDF) which is the overarching document;
- National Environmental Strategy (NES); and
- National Environmental Action Plan (NEAP).

NES is subsequently supported by sub-sector strategies, such as the National Waste Management Strategy and the draft National Water Management Strategy, as well as the National ISPA Strategy for Environment.

2.1.2 The elements of environmental research policy making

According to the strategic document Science & Technology Policy of the Republic of Croatia 2006-2010 main objectives of the science programme of the Croatian Government are:

1. Increasing investments into research and development, and their efficiency
2. Restructuring Croatia's science system
3. Strengthening cooperation between science, government and industry in the creation of new knowledge and goods
4. Increasing participation of Croatian scientists and other bodies in EU Framework Programmes

Although these goals are of general character, there are certainly relevant for environmental research field.
Based on this document, prepared by the Ministry of Science, Education and Sports, a detailed Acton Plan is provided in order to define priorities in the implementation. In the Action Plan 2007-2010 (Science & Technology Policy of the Republic of Croatia) it is stated that the Croatian S&T and innovation policy must be compatible with that of the EU which emphasizes:

- Coherence of innovation policies
- Regulatory framework conductive to innovation
- Encouragement of creation and growth of innovative enterprises
- Improvement of the key interfaces in the innovation system
- Society open to innovation but also take into account the specifics of the Croatian situation.

The Science policy and Technology policy are closely interrelated, both intersecting and complementing each other, with mutually interdependent objectives and outcomes.
The Action Plan 2007-2010 presents strategic research priorities accepted on 25 October 2005 by the National Council for Science. Some of these priorities are of national interest and others are in line with EU Framework programmes (especially FP6 and FP7).
Priorities are divided in two groups regarding the implementation period.
The long-term priorities are:

- Knowledge-driven basic research
- Environmental protection and economic development of the Karst regions; Adriatic Sea, coast and islands
- Agriculture; Biotechnology; Food
- Health
- Information and communication technologies
- Nanoscience; New materials, construction and new production processes
- Energy; Sources of alternative and renewable energy; Transport and security
- Social and human sciences; Croatian identity
- Social integration, learning and education; Lifelong learning

The short-term priorities are:

- Environment (Adriatic Sea, coast and islands; Karst region)
- Health (Food; Agriculture; Biotechnology; Socials aspects of health; Health systems)
- Energy and Materials (Alternative and renewable energy; Bio-nanomaterials)
- Croatian Identity (Croatian contribution to culture, religion, art and sciences; Croatian language)

2.2 Overview of ENVIRONMENT research activities

As official funded projects databases do not recognize environment as separate research area or category, nor detailed breakdown for different research fields exists, the overview presented here is far from being complete or comprehensive.

This overview presents currently funded research projects which were recognized as those belonging to research area of environment. Since research projects are coming from different fields of science, both overview of major research topics and the infrastructure for environmental research are not adequately addressed.

The Ministry of Science, Education and Sports is currently the main funding body for scientific activity which is provided mainly through competitive scientific programs and projects. Pursuant to the Act on Scientific Activity and Higher Education, scientific activity is conducted at the universities, public research institutes, research institutes, Croatian Academy of Sciences and Arts and other legal persons duly registered in the Register of Scientific Research Legal Persons. The Ministry also invites tenders for financing the scientific infrastructure. Based on the evaluation of application the Ministry, in cooperation with research entities, signs agreements and monitors and evaluates their implementation in interim and final reports.

Besides the Ministry of Science, Education and Sports, there are a number of other state agencies responsible for funding S&T research activities in Croatia.

The National Foundation for Science, Higher Education and Technological Development (www.nzz.hr) was established in 2001 with a special purpose to promote science, higher education and technological development in Croatia and with the basic objective to develop economy and promote employment.
NFS has been building its mission based on the Article 3 of the Law on National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia (14th December 2001).
NFS supports scientific, educational and technological programmes and projects and encourages international cooperation within higher education. NFS also supports the realisation of scientific programmes within the field of special interest of basic, applied and developing researches. NFS funds programmes of the higher education that will result in innovations and patents and programmes within higher education, science and technological development that gives the scholarships to the talented students (graduate and postgraduate) especially to younger and significant scientists in economy and research and high education institutions in Croatia.

The other important state agency is Croatian Institute of Technology – HIT (http://www.hit.hr) provides support and guidance for national technological development, monitors and anticipates global technological trends, provides advice and support in the area of intellectual property protection and transfer of technologies. The Institute also provides integration and linkage of scientific research with other segments of the social and economy system in order to set up adequate conditions for innovation and new technologies development. Furthermore, HIT supports Croatian participation in European programmes for research and development and hosts the National Contact Points for the European Communities FP7.

Unity Through Knowledge Fund – UKF (http://www.ukf.hr) is another funding body established by the Ministry of Science, Education and Sports with the support from the World Bank. UKF supports research that is competitive on international level, fosters research that creates new values in Croatian economy and finances projects that help the development of research infrastructure in Croatia. It also finances collaborative research projects and knowledge-based business activities of expatriates and Croatian researchers, institutions and companies.

2.2.1. Environmental research projects

Since there is no systematic data of research projects within the environmental field, this overview is based upon a list of projects among different fields of science, which were recognized as those belonging to research area of environment.

The Ministry currently provides funding for 90 scientific projects with average yearly amount of 84,660.00 kn (€11,516.00). More than 56% of these projects are conducted on the following ten top institutions.

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1. Ruđer Bošković Institute
2. University of Zagreb, Faculty of Science
3. University of Zagreb, Faculty of Chemical Engineering and Technology
4. Institute of Oceanography and Fisheries
5. University of Zagreb, Faculty of Agriculture
6. Institute for Medical Research and Occupational Health
7. University of Zagreb, Faculty of, Mechanical Engineering and Naval Architecture
8. University of Zagreb, Faculty of Textile Technology
9. University of Zagreb, Faculty of Veterinary Medicine
10. University of Zagreb, Faculty of Electrical Engineering and Computing

The National Foundation for Science, Higher Education and Technological Development (www.nzz.hr) in 2007 funded 5 environmental research projects with total amount of 1,579,331.00 kn (€214,874.97).

The Croatian Institute of Technology – HIT (http://www.hit.hr) in 2007 or later provided support for 3 national technological projects with environmental character with total amount of 1,831,000.00 kn (€249,115.65).

Finally, Unity Through Knowledge Fund – UKF (http://www.ukf.hr) funded one environmental scientific research project with value of €200,000.00.

Table 1 Overview of state agencies funds designated for R&D in the field of ENVIRONMENT (in 2007)

	Name	Financing R&D–Year 2007: Total amount in national currency	Financing R&D– Year 2007: Total amount in EUR
1.	Ministry of Science, Education and Sports	7,619,400.00	1,036,653.06
2.	National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia	1,579,331.00	214,874.97
3.	Croatian Institute of Technology	1,831,000.00**	249,115.65
4.	Unity Through Knowledge Fund	1,470,000.00**	200,000.00

**Amounts for multiannual projects

2.2.2 Key competencies in ENVIRONMENT research field

Within the FP7 "Cooperation Programme", the environment theme (including climate change) has a budget of €1.9 billion out of the total €54 billion. A wide range of addressed research topics are grouped into four areas:

- **Climate change, pollution and risks**
  - Pressures on the environment and climate
  - Environment and health
  - Natural hazards
- **Sustainable Management of Resources**
  - Conservation and sustainable management of natural and man-made resources and biodiversity
  - Management of marine environments
- **Environmental Technologies**
  - Environmental technologies for observation, simulation, prevention, mitigation, adaptation, remediation and restoration of the natural and man-made environment
  - Protection, conservation and enhancement of cultural heritage, including human habitat improved damage assessment on cultural heritage
  - Technology assessment, verification and testing
- **Earth observation and assessment tools**
  - Conservation and sustainable management of natural and man-made resources and biodiversity
  - Forecasting methods and assessment tools for sustainable development taking into account differing scales of observation

Within these research topics, competencies of Croatian researchers are visible particularly for:

- modelling of sustainable management of resources;
- observation of marine and aquatic ecosystems;
- chemical speciation in aquatic and terrestrial environment;
- environmental technologies for remediation of the natural and man-made environment and
- development of advanced water treatment technologies for industrial and municipal sector.

2.2.3 Environmental research infrastructure

Scientific activities in Croatia are organised through six major areas: natural sciences, technical sciences, biomedicine and health, biotechnical science, social sciences and humanistic sciences. Since the Environment as particular research field is addressed in almost all of these scientific areas, it is difficult to identify research infrastructure designated especially for the Environment. Thus, environmental research infrastructure in the Republic of Croatia is consisted of larger number of organisational units and laboratories as a part of many research organisations and institutions.

2.3 Key drivers of environmental research

2.3.1. Main environmental sector trends in Croatia

According to the Statistical Yearbook 2008, published by Croatian Bureau of Statistics, the total investments in environmental protection in 2006 are amounted to 1 766 631 000 kn (approx. 241.3 million EUR[4]). End-of-pipe investments amounted to 84.04% of the total amount, while investments in integrated technologies accounted for 15.96%. Out of the total amount of investments, investments in air and climate protection accounted for 13.38%, waste water management 54.23%, waste management 11.51%, protection and sanitation of soil, ground and surface water 18.20%, noise and vibration abatement 1.06%, protection of biodiversity and landscape 0.69%, protection against radiation 0.03% and other environmental protection activities 0.96%.

Total current expenditures for environmental protection in 2006 amounted to 1 538 518 000 kn (approx. 210.1 million EUR).
Out of the total amount of current expenditures for environmental protection, air and climate protection accounted for 3.85%, wastewater management 25.64%, waste management 48.02%, protection and sanitation of soil, ground and surface water 12.34%, noise and vibration abatement 0.06%, protection of biodiversity and landscape 2.32%, protection against radiation 0.14% and other environmental protection activities 7.63%.

Total environmental revenues in 2006 amounted to 1 808 888 000 kn (approx. 247 million EUR). Revenues from providing environmental protection services accounted for 86.24%, from selling by-products of environmental protection-related activities 12.86% and savings from using own by-products of environmental protection-related activities 0.90%.

Gross domestic expenditures for research and development (GERD) by sector of performance are shown in table 2:

Table 2 Croatia GERD by sector of performance in 2006 and 2007

	2006		2007	
	GERD (m €)	(Subsector GERD/ Sector	GERD (m €)	(Subsector GERD/ Sector
TOTAL GERD	€296.7m		€348.59m	
R&D in environment*	**€18.8**	**6.33%**	**€21.86m**	**6.27%**
Business sector	€8.5m	2.86°%	€11.98m	3.44%
Government sector	€4.4m	1.48%	€4.65m	1.33%
Non-profit sector	0		0	
Higher education sector	€5.9m	1.99%	€5.23m	1.5%

Source: *Central Bureau of Statistics*

[4] The annual and monthly averages of Croatian National Bank midpoint exchange rates (2006)

2.3.2 Main socio-economic challenges in Croatia

The Republic of Croatia is a Central European and a Mediterranean country located between the Danube river basin in the north and the Adriatic Sea to the south. Its total surface area is 87,661 km^2, of which the mainland covers 56,594 km^2, whereas coastal waters account for the remaining 31,067 km^2. The country is divided by two marine catchments areas, the Black Sea and the Adriatic Sea, each with two river basins: the Sava, Drava and Danube feed the Black Sea, and the Primorsko-Istrian and Dalmatian drain into the Adriatic.
Its geophysical location in Europe determines the environmental characteristics of the country, with the long coastal region, littoral highlands and the central plains. However, the dominant geological factor, the karst region, determines the most significant environmental issues in the country. Croatia's karst region is a unique relief with special hydrogeological and geomorphological features where ground waters are much more abundant than surface water. The surface watersheds substantially differ from the underground ones and in which characteristic surface forms (limestone cracks, sink-holes, karst valleys, subsidence valleys, etc.) and underground forms (caves and pits) occur in tectonically fragmented, carbonate, evaporite or gypsum rocks.
Croatia is in the process of establishing the Natura 2000 network. The country has a considerable wealth and diversity of flora and fauna. Croatian protected areas cover a land area of a total of 5,379.41 km^2 or cca 9.5% (compared to the EU-15 level of 12.4% in 2004). The major part of this area is protected as nature and national parks. Economic development will continue to exert pressure on the natural resources and biological diversity; and these protected areas need to be safeguarded.

Croatia's population numbered 4.437 million in 2001, which makes an average population density of 78 inhabitants per km^2 with slightly more than 69% of the population being urban; on the basis of these statistics, Croatia is one of the least populated European countries. The most densely populated part of the country is the northwest, which is inhabited by almost 40% of the total population in what is about 15% of the area of the country. A lower, but still above-average, population density is found in the easternmost, westernmost and southernmost parts of the country, whereas the vast central area, which covers 50% of the country, is considered demographically and economically "impoverished".
Croatia is divided into 20 counties and the City of Zagreb; the counties contain 425 municipalities and 124 towns. Four cities, the capital Zagreb, and Split, Rijeka and Osijek, are inhabited by about 25% of the total population and represent the major urban and development centres with significant surrounding wider economic catchments areas.
The average size of the counties is somewhat above 180,000 inhabitants and 41% of the population lives in counties with less than 200,000 inhabitants. However, in these counties, unemployment runs at 20% and their average contribution to GDP is around 80% of the national average.[5]
The state of the environment in Croatia has been assessed on a regular basis and is considered to be generally good. The State of the Environment Report for the period 1997-2005 was adopted by the Croatian Parliament in May 2007. The 2002 NES identifies 13 priorities, of which the top two are waste and water. Air quality is third, the Adriatic (the sea, islands and coast) is a fourth and soil protection is fifth. Nature protection is the sixth priority. Waste is the top priority because of the legacy of the past, when there was limited compliance with waste legislation and poor waste management practices; this led to a profusion of illegal waste

[5] Environmental Operational Programme 2007-2009 (2007HR16IPO003)

dump sites, which are hazardous to health, unsightly and pose a risk of groundwater contamination.
Water is also a priority in the environment sector, but the investment required is the greatest, particularly in upgrading water treatment facilities and building sewerage networks. Effluent from rudimentary treatment systems is the main cause of water pollution, particularly in rural areas where half the population lives, but also from large settlements where the level of treatment is inadequate. The same applies to the air sector – high investments are needed but integration of air quality requirements into the other sectors – especially in energy production, transport, industry and agriculture - is not a priority for this programming round. Care must be taken particularly for the balance between raising air quality and activities undertaken on behalf of economic developments.

3. Integration of Croatia in the European research area in the field of environment

The Seventh Framework Programme for research and technological development (FP7) is the European Union's capital instrument for funding research during the period 2007 to 2013. FP7 environmental research has a twofold objective: on the one hand it is to promote the sustainable management of the environment and its resources through increasing knowledge about the interactions between the climate, biosphere, ecosystems and human activities. On the other hand, it is also to develop new technologies, tools and services that address global environmental issues. Emphasis is being placed on prediction tools and technologies for monitoring, prevention, mitigation of and adaptation to environmental pressures and risks. Specific attention is also being given to informing decision-makers in their design of environmental policy, as well as business leaders and ordinary citizens about the challenges and opportunities they face.
The challenges posed by the increasing natural and man-made pressures on the environment and its resources require a coordinated approach at pan-European and international levels.

Resume of Croatian participation in FP7 environmental research is given in table 3.

Table 3 FP7 research project with Croatian participation in the field of Environment

HUNT	Project title: Hunting for Sustainability Proposal call: FP7-ENV-2007-1 Participant Legal Name: University of Zagreb, Faculty of Veterinary Medicine Project Start Date: 1.11.2008 Project Funding Scheme: CP-SICA
PRIMA	Project title: Prototypical Policy Impacts on Multifunctional Activities in rural municipalities Proposal call: FP7-ENV-2007-1 Participant Legal Name: University of Zagreb, Faculty of Agriculture Project Start Date: 1.11.2008 Project Funding Scheme: CP-FP
SMooHS	Project title: Smart Monitoring of Historic Structures Proposal call: FP7-ENV-2007-1 Participant Legal Name: University of Zagreb, Faculty of Civil Engineering Project Start Date: 1.12.2008 Project Funding Scheme: CP-FP

Besides EU framework programmes, Croatia participate in COST which is an intergovernmental framework for European Cooperation in Science and Technology, allowing the coordination of nationally-funded research on a European level. COST aims to reducing the fragmentation in European research investments and opening the European Research Area to cooperation worldwide.

The objective of COST is to ensure that Europe holds a strong position in the field of scientific and technical research for peaceful purposes, by increasing European cooperation and interaction in this field. This research initiative makes it possible for the various national facilities, institutes, universities and private industry to work jointly on a wide range of Research and Development (R&D) activities.

Croatian researchers take part in three COST undergoing projects.

1. Xenobiotics in the Urban Water Cycle

   Ruđer Bošković Institute, Zagreb
   University Zagreb, Faculty of Geotechnical Engineering, Varaždin

2. Impacts of Climate Change and Variability on European Agriculture (CLIVAGRI)

   DHMZ – Meteorological and Hydrological Service, Zagreb

3. Advances in Homogenisation Methods of Climate Series: an Integrated Approach (HOME)

   DHMZ – Meteorological and Hydrological Service, Zagreb

4. SWOT analysis of ENVIRONMENTAL research capacity in Croatia

Strenghts	Weaknesses
• Environment (specifically for Adriatic Sea, coast and islands, Karst region) is second among identified 9 long-term and first among 4 short-term priorities for Croatia (Science & Technology Policy of the Republic of Croatia – Action plan 2007-2010) • R&D funding growth • Good international contacts • Developed outgoing mobility • Some groups have experience in international projects • Number of researchers with expertise in advanced research technology • Experience in knowledge transfer to industry, SMEs and government	• Lack of specific research strategies • Lack of human resources for research • Fragmented research structure • Lack of equipment for participation on international level • No major research infrastructure specific for the field • Weak domestic governmental support for R&D • Weak incoming mobility • Lack of cooperation in R&D on regional level

Opportunities	Threats
• Increased scientific productivity in the environmental field • Better protection of environment in most sensitive areas • Recognized R&D priorities on regional level • Stronger cooperation in R&D on regional level • Increased capacity to participate in research on international level • Increased participation in FP7 and other EU programmes • Better international contacts • Developed ingoing mobility	• Limited R&D expenditure, especially concerning ongoing financial crisis • Weak domestic governmental support for R&D • Insufficient direct communication between research and industrial sectors • Brain drain • Global and local financial crisis • Low private investments in R&D • Local development plans do not focus on research issues

4.1. Strengths

According to the national strategic document "Science and Technology Policy of the Republic of Croatia – Action Plan 2007-2010", environment is recognized as high priority issue. Special attention was given to Adriatic Sea, coast and islands, and karst region which are most demanding for protection but also for research.

Some research groups have established good connections with universities and institutes in the EU and the USA, with developed outgoing mobility. This is followed with the increased number of publications in peer reviewed international journals.

4.2. Weaknesses

There are several reasons for lack of human resources for research in Croatia. The brain drain of researchers and experts attracted by better conditions in the private sector or international companies is certainly important but there are also other reasons as weak domestic governmental supports for R&D, missing and aging of laboratory and experimental equipment which is unsatisfactory for complex and attractive research. Indeed, some major, widely recognized research infrastructure specific for the environment does not exist.

Small funds for R&D and S&T equipment resulted in great difference in quality and conditions for research comparing to those in respectable laboratories in the EU, and that might be the major reason for poor incoming mobility of experts that could initiate capacity building. As it is previously mentioned, some groups have capacity to participate in FP 7 projects but their participation is restricted as most of them are small and focused on particular research. Thus, due to lack of capacity or expertise, they are unwilling to change to new and more attractive research topics. Moreover, fragmented research structure is consequence of non existing official research strategies at national level that could set common objectives which then should be followed by different groups. Collaboration among national research institutions is very low, resulting in poor use of capital equipment and infrastructure.

Finally, all these weaknesses of Croatian research society are resulting in poor visibility and lack of research capacity for stronger cooperation on international level.

4.3. Opportunities

Although it seems that weakness forms closed circle which does not allow any improvement, it is realistic to expect that major restructuring of grant support in Croatia could capitalize current strengths and exploit opportunities, which would lead to real changes with significant impacts. It is desirable to start integration of R&D at the institution level preferably around strong research topics that are part of a current framework program but are also of great interest for region and EU in longer period. Environment and sustainable development are of major interest for Croatia and the EU and needs for research in these areas are requested by several national but also EU Directives, programmes and strategies.

Besides, by providing innovative tools and knowledge transfer for developing of new technologies for the environmental protection and by linking with local SMEs it is possible to influence directly on the local economy and employment.

Enhanced research activity will certainly make Croatian research institutions more attractive partners for international collaboration for R&D in environmental sector.

Different research groups in Croatia have a big experience in environmental research which is reflected through their scientific achievements and cooperation with different domestic and international companies, SMEs and government institutions.

4.4. Threats

Even though environment as a priority is set high in national strategic documents, there is no specific research strategy within the broad area of the environment.

Low level of communication among research institutions and resulting insufficient use of major research infrastructure and equipment pose serious resistance for improvements.

Furthermore, generally low salary in S&T sector and inability to compete with other advantages in commercial sector supports brain drain especially for younger ones. That could even deepen the lack of human resources for research in Croatia, particularly due to ongoing global and local financial crisis.

5. Environmental research priorities for Croatia

According to the national strategic document "Science and Technology Policy of the Republic of Croatia – Action Plan 2007-2010", environment is recognized as high priority issue. Special attention was given to the karst region and Adriatic Sea, coast and islands, which are most demanding areas for protection but also for research.
Consultation process with leading scientists in the field has identified more in detail following priorities for environmental research:

5.1. Sustainable management of resources

5.1.1 Conservation and sustainable management of the Adriatic Sea including coastal zone and islands

Sustainable management of the Adriatic Sea aims at protecting marine ecosystem without compromising economic growth. This is particularly related to fishery and fish and shellfish farming. This topic should be considered in a multidisciplinary context, including natural sciences, socio-economic planning and decision-making.
In order to fulfil the aims of the topic, two approaches will be developed:

- An ecosystem-based approach, whereby activities affecting the marine environment will be managed in an integrated manner promoting conservation (long-term objective) and sustainable use (e.g. periodic planning of fisheries) in an equitable way of coast and islands.
- A knowledge-based approach, in order to achieve better connection to policy-making.

5.1.2 Conservation and sustainable management of the karst area

This particular topic should consist of the following important issues:

- Development of integrated resources use based on improved understanding of complex human-environment interactions in vulnerable karst region.
- Detection of environmental quality regarding soil contamination, pollutant presence in ground water and air, recognition of most endangered areas and hot spots.
- Determination of the pollution immission and listing of pollution emitters in the area.

5.2 Environmental technologies

5.2.1 Advanced water treatment systems for industrial and municipal sector

The aim is to develop environmental technologies with emphasis on innovative system solutions wherever conventional waste water technologies do not provide satisfactory results.

The presence of active pharmaceutical ingredients and personal care products in surface waters is an emerging environmental issue and provides a new challenge to drinking water, wastewater, and water reuse treatment systems.
Recent studies have shown that conventional water treatment processes are relatively inefficient in their removal from water. In addition, these technologies require the disposal of wastes such as membrane retentate or spent activated carbon.

5.2.2 Integrated waste management

Introducing integrated waste management and the sanitation of existing effects arising from the inadequate management of waste are of particular importance in the achievement of sustainable development. It is therefore necessary to establish an integral waste management system which will provide:

- Reduction of the environmental impacts,
- Increased participation in separate collection programs for recyclables and hazardous waste,
- Opportunities for new or expanded services.

Although some of the proposed activities have been recently undertaken by Croatian government, S&T sector has not been involved to a greater extent so far. Therefore, it is necessary to implement research programmes to support successful introduction of waste prevention, recycling and cleaner technology, especially with regard to peculiar karst and Adriatic areas.

5.2.3 Ballast water issue

It is well known that ballast water is the major pathway of transmission of non-indigenous species (NIS) across bio-geographical boundaries. The ecological, economic and even human health impacts of aquatic bio-invasions are considerably more severe than all other forms of ship-sourced pollution. In order to evaluate incurred changes and the extent of impacts on marine communities of the Adriatic Sea, the baseline assessment of native and non-indigenous species is required prior to any other activity.
The only management strategy currently available for ships to reduce the introduction of NIS is open-ocean ballast water exchange (BWE). Due to obvious limitations of current practice of BWE, there is a great need to develop effective ballast water treatment technology (BWTT) that would provide technological alternative to BWE. Consequently, further research in the area of BWTT has to be fostered as it holds important role in Croatian S&T sector.