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Editor Antti Roose

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Progressing water geography discourses in the framework of the Erasmus seminar series

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Water is a valuable resource and a major concern for ecological and economic development. Increasing demand and consumption of Europe´s water resources as well as growing pressures from the direct and indirect effects of climate change have raised the interest and need towards more sustainable water policies across Europe. This recognises the territorial phenomena which underlines the importance for quality of life, environmental well-being, social justice and economic growth.

The seminar series on the geography of water was launched in Padova in 1994. It aimed at enhancing students' knowledge and skills on environmental and territorial sustainability through a multidisciplinary approach to different water related issues. A 12 day long residential seminar has been held in various parts in Europe 17 times, where students have had the opportunity to improve their understanding of the interdependence of water resources, the vulnerability of ecosystems and local communities, sustainable water policies, and water management in an interdisciplinary multi-scale spatial planning approach. The course targeted postgraduate students, young researchers, and professors from the various scientific disciplines. The long-running academic initiative developed teaching methods and innovative didactics, prepared new e-materials, applied e-learning methods and tools, and facilitated collaboration and academic forum between European universities.

1. Introduction

Water as an essential and vulnerable resource needs to be acutely addressed, and sustainable management of water resources is becoming more relevant each year, throughout the world as well as in Europe. Over the coming decades, climate change will have a significant impact on the quantity and quality of water resources both within Europe and globally (IPCC, 2014). Climate change is expected to increase the amount of EU territory exposed to water scarcity as it aggravates existing pressures on water resources from, *inter alia*, pollution, overuse, and population increase. That is why since 2011, the thematic focus on climate changes and sustainable water policies was chosen for the seminar with an emphasis on the Mediterranean region as one of the areas suffering from intensive human development and is thereby highly susceptible to climate change impacts. During the water seminars, a number of opportunities and solutions for how to adapt with these changes was discussed and proposed for policy implementation. Still, the traditional spatial organisation of water policies remains disintegrated, while patterns of complex relational dynamics of water geographies is difficult to model and to grasp (Healey, 2007). It requires connecting understanding of residents, economic actors, regulatory powers, engineering capacity and other potentialities and limitations of strategy-making. Our academic enthusiasm and action meandered around in water discourses and in territorial approaches.

The paper setting the scene for the proceedings introduces the enhancing of the water geography paradigm by seventeen European seminars on the geography of water held in the framework of advanced postgraduate summer schools across Europe since 1994. The series of seminars is held within the framework of the Erasmus Intensive Programmes, the Lifelong Learning Programme, formerly the Socrates programme. The programme has been organised as a training course for post-graduate students and young researchers in order to promote an intercultural exchange on the scientific and educational level among participants coming from different European countries. The programme compounded two main activities. The first, an advanced residential seminar for graduate students, is organised annually, focusing each year on a specific discourse, aspect, or approach within the broad spectrum of the geography of water and exemplified by the case region. The second, a growing network of relations among the participating universities, has been established and has promoted academic cooperation and exchange in scientific, didactic, and professional matters within the field of water geography. From 2005 the Erasmus project on the geography of water was coordinated by the University of Tartu as a continuation of the leadership of the Johannes Gutenberg University Mainz.

In 2006, the project was titled as Water Resources and Conflicts in Southern European Ecoregions – Pontic Province and Mediterranea. In 2008–2010, the project head was Water Resources, Management and Security in Southern Europe. In 2011–2013, the project was titled as Sustainable Water Policies in Europe, and in 2014, Strategic Planning of Water Systems in Europe. The approach, context and debate were always related to the territorial dimension and to the policy practice of the region where the seminar was held. Discussions among academia, industry, agriculture and government, and (importantly) communities held within the doctoral programme have considerably enhanced the knowledge, interpretation, and implementation of the key provisions of the Water Framework Directive (WFD) as well as place-based policies in general (Barca Report, 2007), whether on tourism and rural development or the socio-economy of the local community in relation to waters. We elaborated the understanding of water security. Since 2011 the environmental and socioeconomic impacts of climate change enhanced the debate on sustainable water policies across countries and stakeholders. For the last few years, the project has intended to link water management with strategic spatial planning, focusing on the relation of water management and territorial governance, advocating developmental policies to be 'place-based' (Barca Report, 2009) and promoting smart, inclusive and sustainable growth as stated in the Europe 2020 strategy.

2. The concept, objectives, and partnership

The seminar concept is based on multidisciplinary and multi-scale approaches to sustainable water policy and management. The interdisciplinary character of water discourse allows cross-disciplinary debate between not only geographers but engineers, geologists, economists and ecologists as well as social sciences fellows.

The main objectives of the seminar were as follows:

- improving quality and increasing volume of water(related) sciences student and teaching staff mobility throughout Europe, enabling up-to-date integration of postgraduate programmes on geography of water in European universities;
- advancing the pan-European water geography discourse by facilitating the development and sharing of innovative practices on water subjects;

- a robust European roadmapping; every region represented by the partner university has its challenges regarding implementation of WFD, promoting a practical dimension of European water policies;
- water policy support: applied study and contemporary research bridged the gap between the theory and operational water management, allowing understanding, and projecting and processing analyses of geographical thoughts on contemporary water management;
- pan-European expansion of intercultural exchange.

The academic approach was based on practical studies, integrating methods, instrumental testing, and application of results. In terms of methodological complexities in the field of water sciences, the seminar promotes interdisciplinarity, critically discussing theories, methods, and practices.

The number of participating institutions, the wide-ranging national and expert background all over Europe, the long existence of the network, and its expanding character guaranteed high-standard multi- and intercultural exchange and cooperation, thus supporting stability and security in the EU and its neighbouring regions. Teachers, specialists, and students contributed to the multinational approach in teaching and communicating according to their fields of study, academic, and professional background. In collaboration with specialists from diverse backgrounds and universities, more complex understanding about different water-related issues and topics was achieved. The programme provided the participating researchers, and professors with considerable experience and knowledge to implement the interdisciplinary approach in their home universities. Through improving social cohesion and recognition of prior learning creating, the European Higher Education Area is supported. The added value to current studies at the home universities is the sharing and distribution of know-how among diverse backgrounds and traditions and was another aim of the programme throughout the years.

During 2011–2014, the participating universities were University of Tartu, Estonia; University of Udine, Italy; University of Cagliary, Italy; University of Padua, Italy; University of Pécs, Hungary; University of Prague, Czech Republic; University of Sevilla, Spain; Sofia University St Kliment Ohridski, Bulgaria; Babes Boljai University Cluj-Napoca, Romania; Ludwig Maximilians University, Munich, Germany; and University of Zadar, Croatia. As former members of consortia, Johannes Gutenberg University of Mainz; University of St Etienne, France; Linköping University, Sweden; Middlesex University, United Kingdom; University of Lisbon, Portugal; etc. contributed academically and institutionally during 1990s and 2000s. The European Union enlargement was reflected by the eastward enlargement of the academic consortia, involving Estonia, Czech Republic, and Hungary in the first wave since 2001, and Bulgaria, Romania, and Croatia in the second wave since 2006. Also, Germany (represented by the Ludwig-Maximilians-Universität München) came back in 2011.

3. Innovations in didactics and learning methods

In a course of seminar series we moved from knowledge transfer to knowledge engagement and co-creation beyond academia studying shoulder to shoulder together with multiple stakeholders from officials and businesses to neighbourhood communities and environmental NGOs. Our ultimate strength was off campus. Various pedagogical and didactical approaches were used throughout the seminar series, primarily research, data management, didactical methods (key-note lectures), meetings, working group sessions, e-learning, technical visits, survey, and field work which have been organized in an integrated way. It was laboratory for academic teamwork.

Table 1. The European seminar series on the geography of water 1994–2014.

No	Year	Location	Theme	Focus/workgroup
1	1994	Padova, Italy	Water management and territorial dynamics	Territorial planning
2	1995	St. Etienne, France	Problems, methods, and spatial tools for water management basins	Geographical Information Systems and spatial methods
3	1996	London, UK	Perceptions of the value of water and water environments	Valuation and social cost of water
4	1999	Cagliari, Italy	Conflicts on water use in the Mediterranean Area	Development pressures, tourism impacts
5	2000	Linköping, Sweden	"Hydrocide"	Global water problems
6	2001	Mainz, Germany	Living at the Rhine, Problems of future development in the valley of the upper and middle Rhine	Complexity of Rhine: urban and economic development, tourism and recreation, flooding, water resource management
7	2003	Prague, Czech Republic	Water management in transition countries; water resources, their management and protection in Central Europe	River basin management and water quality
8	2004	Pecs, Hungary	Water management in transition countries; Water-related conflicts between the society and nature in Hungary	Water issues of transition countries
9	2005	Tartu, Estonia	Integrated water management of small river basins. River basin management planning in South-Estonia	Small river basin management; Lake Peipsi as cross-border water body
10	2006	Sevilla, Spain	Water management in the South of Spain. Managing drought and water scarcity in vulnerable environments	Drought management; agriculture and irrigation; river restoration
11	2008	Sofia, Bulgaria	Water security problems in Bulgaria	Global water security; coastal zones; trans-boundary river management: Danube case
12	2009	Udine, Italy	Water resources, management and security in Southern Europe	Sub-mountainous catchments, lagoons, karst
13	2010	Cluj-Napoca, Romania	Community scale water management patterns in Transylvania	Groundwater; mineral water; rural tourism, participatory approach
14	2011	Cagliari, Italy	Environmental conflicts and sustainable water policies in the Mediterranean Region	Territorial planning in wetlands; challenges in tourist areas; climate change and desertification
15	2012	Munich and Fischbachau Germany	Modelling and management of water quality in European lakes and reservoirs - Impacts of climate change	Aquatic and climate change modelling; water and energy plant cultivation; lakes as magnets of tourism in Upper Bavaria
16	2013	Zadar, Croatia	Water management in coastal and insular karst areas	Water on islands; environmental protection vs agriculture; indicators of climate change
17	2014	Padova, Italy	Historical perspective the water systems and spatial planning in the Southern Venetian Plain	Water-related planning conflicts; flooding hazard assessment; water-related tourism

The emphasis was placed on training in methodological approaches to environmental assessment within the working groups, thereby creating different modules of applied methodology in a defined case study according to which the working groups would be formed (i.e. mapping and GIS-processing, statistical modelling and empirical studies, economic and environmental assessment, etc). The topics of case studies and working groups were specified by the host university according the focal theme, possibilities and environment for practical studies.

The host university performed background research and compiled the data set and methodology necessary to present the themes of interest and issues covered during the summer seminar. Based on information gathered from lectures, field observations, literature, excursions, and other sources, the members of working groups produced summaries and conclusions according to a given theme and subtopic. The instrumental testing enabled students to develop and test the various scientific hypotheses in relation to territoriality of water problems, synthesising the outputs in a larger network of European experts, reaching Europe-wide conclusions and recommendations for policy-making. The output of the working groups was presented and discussed comprehensively at the end of the seminar.

Before the seminar, distance learning was performed via e-learning, using the web environment and the various pedagogical possibilities created by the web-page for the programme. Elaboration of the web environment throughout the project cycle has contributed to the integration and use of information and communication technologies (ICT) in the teaching and learning methodologies. The seminar focused on the possibilities and opportunities of ICT in-depth. The seminar materials are available at http://taurus.gg.bg.ut.ee/erasmusip/.

The target groups were postgraduate students, and they got special academic treatment. The students were selected by the university coordinators through an individualized selection procedure based on academic accomplishments, scientific abilities and interests, personal motivation, and communication abilities such as teamwork and language proficiency.

4. Evolving ideas, concepts and geographies

The seminar series succeeded in reaching multiple frameworks, dimensions and (multi)disciplinary angles in the field of geography of water.

- *Theories and epistemological foundations* for research on geography of waters introducing the history of water research, offering an overview of contemporary research directions in water studies, emphasizing the crucial importance of various forms of institutional settings, EU policies and politics, and socioeconomic justice.
- *Macro-geographic implications*: dry, moderate, or wet climate in hydrology research, recently EU macro-regional approach for cross-border territorial development policies.
- *Cross-boundary implications* of water bodies and their management: Lake Peipsi, Estonia-Russia in the 2005 seminar; Danube, Bulgaria-Romania in the 2008 seminar; karst, Italy-Slovenia in the 2009 seminar.
- *Scale and size as spatial phenomena and its policy implication*: big river basins versus small tributaries 2001; big lakes versus small lakes 2005; mass tourism versus nature tourism 2008, 2011, and 2013.
- *Multi-scale approach* in the case of the 2009 seminar in Udine, Italy: a large-scale approach on the Mediterranean basin level, a medium-scale approach on the Friuli

Venezia Giulia region, and river basin scale in the lagoon of Grado–Marano and the Tagliamento river basin.

- *Water security* in relation to global environmental change, climate change, and changes in hydrological cycle were given from the beginning of the seminar series since 1994, a focus in particular in Sofia 2008, in local level in Zadar 2013.
- *Urban/rural dilemma and its territorial and water policy implications*. The mutual relationship between urban and rural areas and water approaches is discussed through the seminar series, in Tartu, Sevilla 2006, Sofia 2008, Cluj-Napoca 2010, Munich 2012.
- *The participatory approach and participatory planning* is stressed while solving conflicts between values, goals and interests on the stakeholder level, public vs private interests, in particular in Udine 2009, Cluj-Napoca 2010, Cagliari 2011, Munich 2012.
- *Territorial governance and institutional settings* implementing water policies received a special attention in the programme in Sevilla 2006, Udine 2009, Cluj-Napoca 2010, Cagliari 2011, Zadar 2013.
- *Technological innovation* of water engineering, hydropower, irrigation and water quality was discussed in Tartu 2005, Sevilla 2006, Bulgaria 2008, Cluj-Napoca 2010, Cagliari 2011, Munich 2012.
- *Socioeconomic aspects* of economic development, social welfare and justice, environmental conservation are covered comprehensively by all seminars. Uncertainty and instability in the economic-social process affect water management.
- *Law and order:* European Directives, in particular 'European water constitution' WFD and its top-down normatives were contextualised and critically applied in case studies as well law enforcement and conflict resolution cases were studied in many seminars.
- *Tourism and recreation* as one of multiplier sectors was targeted in the majority of seminars during last decade, in particular in Bulgaria 2008, Udine 2009, Cluj-Napoca 2010, Cagliari 2011.
- *Developing countries*. Numerous case studies of developing countries presented: current water issues and solutions in India, Brasilia, Peru, Algeria, Senegal, Burkina Faso and Kyrgyzstan were presented and discussed.

The 2005 seminar introduced small river basin management in Southern Estonia. In 2006, in Sevilla, the seminar focused on water scarcity and drought in Spain, Andalusia as well as across Europe. The WFD challenges were exemplified by the Guadalquivir River Basin as well as by the Guadiamar and Guadaira rivers; tourism impacts in the Malaga region, irrigation as the main water demand sector in Mediterranean Countries. Modernization of irrigation schemes and impacts of the European Common Agricultural Policies were illustrated by the case of the Huelva coast and Doñana (Roose, 2006). The seminar in Bulgaria in 2008 focused on the following subthemes: water in the world – risk related to the water in different parts of the world; dimensions of water security; water security problems in the Bulgarian coastal zone; and international rivers and water security problems: case study of the Danube River (Roose, 2009). Water management of sub-mountainous catchments (engineering against floodings), lagoon environment (sustainability of fishing communities), and cross-border karsts are debated in the Udine seminar in 2009. Interrelations between spatial planning and water management, groundwater pollution, and mineral waters are elaborated in the Transylvanian case studies in

Cluj-Napoca, Romania in 2010. In 2011, the Cagliari seminar focused in territorial planning in wetlands as well challenges in tourist areas (seasonal impacts and deficiencies in relation of water usage) and climate change/desertification was discussed in-depth. The Munich seminar in 2012 explored research excellences in aquatic and climate change modelling, in addition impacts of expanding bioenergy sector and tourism sector were discussed in Bavarian contexts. In 2013, the Zadar seminar turned to basics of Earth sciences discussing man-nature/water relations in islands and karst areas. The Padova seminar in 2014 is going to explore geo-historical evolution of the water environment using geoarchaeological methods.

In this progression, the students received detailed insight about the interdependence among water resources and about concepts and practices of water security, in order to demonstrate and explore the mutual confrontation of water policies and practices and to show the interdisciplinary nature of geographies of water. We have seen water management and policies from the inside, did real research work and experienced water research in other European regions. It was a series of seminars each attempting to say something special and specific about the region.

In general, the Erasmus seminar on the geography of water advanced the pan-European water geography discourse, enabling up-to-date integration of postgraduate programmes in European universities as well as promoting a practical dimension of European water policies, implementing the Water Framework Directive in the ethos of sustainable development and place-based policies.

5. Academic outreach and achievements

We were very motivated. The results of the IP were disseminated to partner universities outside the consortium, to governmental and local institutions and NGOs in participating countries who are active in water and resource management, environmental protection, spatial planning, regional development, etc. The seminar series diversified the scope of water-related and environmental issues as the project went for maintaining relevance of various water-related problems and raising the popularity of science. Dissemination means included e-mail, post, internet, personal contacts, consultations and seminars, and outreaching regional media. The residential seminar was very often covered by local and academic media, we were staring at newspapers, TV and radio. The social media brought new solutions and faster, more targeted and individual communication of the annual academic event.

Spin-offs involved integration of modules on strategic territorial planning and water management to be developed within the programme into the regular curricula of the master and doctoral level of the participating universities. It improved the overall quality and competitiveness of education in the field of territorial and regional planning; enhanced comprehension on the subject of water management and strategic planning, implementation and benchmarking EU 2020 strategy, various EU legislative initiatives toward planning, sustainability, and climate change. Always, we took in consideration diversity and differences of European regions. We initiated several other academic and research projects in the field of geography of water and regional studies as a result of academic partnership.

We believe that progress is about a brighter use of our territorial capital. The European regions are filled with public and private actors at multiple levels of spatial scale and they are interactive in various fields of regional policy. The Erasmus seminar series enhanced, integrated, connected and harmonised those different areas of knowledge and practice around a territorial focus, and shaped the future trajectory of territorial development as well academic thought in geography of water. Geography of water has won.

PS On August 22, 2005 I was defending my PhD thesis in GIS for environmental monitoring. The highly academic Scientific Council room in the University of Tartu main building was packed with my friends, colleagues and the geography of water Erasmus scholars. Full house. It was a very special moment as well as a nervous one. I realized that I felt I was understood there. As a coordinator, I am grateful to the founders of this seminar series and to all the universities, professors and students for this truly diverse and inspiring pan-European academic journey.

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The tradition of the European seminar on geography of water in Padova: Experience in research and training

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This work presents the experience of researchers and students from the University of Padova in the Intensive Program Erasmus of European Seminar on Water Geography. Since the Seminar originally began at the University of Padova (Pierpaolo Faggi as coordinator), a historical excursus of the Seminar, from its birth in 1994 to the last edition in Zadar on July 2013, is first provided. Each year as a tradition, PhD students and young researchers of the Department of Geography (from 1994 to 2010) and, later, the Geography Section of the Department of Historical, Geographical and Antiquity Sciences (DiSSGeA) (from 2011 to present) attended the Seminar, were involved in working group activities, and participated in the discussions of their research. Thus, a summary of the contributions by University of Padova participants is given with an examination of the changes in research themes during the Seminar history.

1. The beginning

The origin of the European Seminar on Geography of Water began with a network of universities (13) and actors who had played a significant role in the promotion and realization of the project. The Seminar initiative started with the traditional Erasmus Intensive Programme, through which the Department of Geography of Padova (Pierpaolo Faggi) had existing relationships with the University of St. Etienne (Jacques Bethemont) and the University of Alicante (Antonio Gil Morales and Alfredo Olcina). A key player at the University of Padova was Luigi Filippo Donà Dalle Rose, head of the Erasmus Exchange Program, who had always pushed towards international partnerships and exchange programs. Later, the School of Oriental and African Studies (SOAS) Water Issues Group of the University of London and the STRATES Lab, University Paris 1 – Panthéon Sorbonne became involved. The SOAS Water Issues Group, directed by Anthony Allan, was one of the most important international centers for research on water in the Middle East. The STRATES Lab, where Véronique de la Brosse was a key member, was the organizer of a conference on water in Africa. Another key research component was the ongoing water research by Pierpaolo Faggi at the Department of Geography in Padova. In 1994 a research effort by Faggi in Sudan (Bertoncin *et al.*, 1995) had just been concluded and a new water research effort begun in the Xinjiang desert in China. These two studies led the Padova Department of Geography to develop a meditation on hydraulic territorialization, focusing on water management, covering not only physical, social and economic geography, but including the broader research questions on territorial management. The Padova Department of Geography was ready to put the result of these works in an intensive Seminar program. Moreover, after 1994 the research in the Sahel began, and in 1997 the project "Adottiamo l'acqua" ("Let's adopt the water") began. In 1998 the International Seminar "Il governo dell'acqua tra percorsi locali e grandi spazi" ("The water governance between local paths and wide spaces") was held in Portogruaro (Faggi and Rocca, 1999). The setting-up of an Institutional network ended with the International Conference "Geografie dell'acqua. La gestione di una risorsa fondamentale per la costruzione del territorio" ("Geographies of water. The management of a vital resource for the construction of the territory") held in Rieti in 2003, the International Year for Freshwater. So these three founding "patriarchs" of the European Seminar on Geography of Water were the Erasmus institution and program (for relations and educational aspects) and the experience of key research efforts at Padova, London, and St. Etienne involved in water research.

To summarize, the initiative of the Geography of Water IP was created from a series of links between institutions and the research unit on water and territorialization processes at the Department of Geography in Padova. A project, such as the GoW IP, should be born from the interaction between these different components, where the interest of research groups has the key role.

In the second (1995) Seminar on Geography of Water, the Universities of Cagliari and Udine participated, with Giovanni Sistu (Cagliari) and Franca Battigelli (Udine) in bringing students. Other foreign universities joined the Seminar in subsequent years: Porto, Mainz, Seville and Linköping. These institutions were all new links that joined, identifying cognizant scientists working on water research, with the idea of building a European network in the way it has been built.

An interesting procedure was adopted to expand the network: each year, the organizer of the Seminar invited universities from other countries with which the organizer was connected. Thanks to this strategy, the network expanded to fifteen universities. Later, the network had grown to a dynamic form: coordinators and universities changed during that time, but the participation of the University of Padova remained consistent.

2. What kind of commitments and methodologies are involved in the organization of the Erasmus IP on the Geography of Water?

The Seminar involves a large network consisting of an ownership and promotion stage. The organizer of the Seminar becomes the 'owner' for a year and plays the role of a 'leader'. However, the Seminar works well when there is a shared ownership between all participating universities – in other words when it becomes a common affair. The original management passed from the University of Padova to the University of Mainz and then to the University of Tartu, which currently manages the Seminar. A considerable amount of logistics and paperwork are required by each organizer. For instance, a dossier is required, which includes a challenging project, goals and resources, as well as networking to engage colleagues from the other universities.

The organization of the Seminar activities is a very important educational issue. This organization goes beyond the practical issues and follows immediately from the rationale of the Seminar organization. The original organizational approach intended to bring together water scholars – from professors to PhD students – to think (and even argue) together on the theme of water by means of a relational approach and discussions. For example, the first Seminar was set up in three stages: 1) lectures of professors, 2) presentations of the graduate students' research, and 3) a working group session. During this first Seminar, the second stage might be regarded as a failure as the graduate students simply read their presentation as if they were participating in a conference (everyone in their own language), favouring the exposure at the expense of communication1. Following this first Seminar, the working groups became the key focus for the seminar, reaching its best example at the Seminar of Cagliari. The Cagliari Seminar was managed by Giovanni Sistu (scientific contents) and by Marina Bertoncin (organization of the working groups). The focus of the Cagliari Seminar was on water scarcity and the conflicts related to Capo Teulada in the Southwest of Sardinia.

3. What were the research contributions from University of Padova participants?

During the twenty years since the birth of the Geography of Water Seminar, the research contributions from the participants of the University of Padova moved from topics mainly focused on Human Geography as territorialisation and development to a range of topics that involved both Human and Physical Geography as water conservation, palaeogeography, and flood risks (Table 1). In this sense, Padova participants somehow followed the shift witnessed in the Seminar itself, from a more theoretical concern about the role of water in the geographical set-up towards a more applied/management concern.

Table 1. Contributions of the Department of Geography at the Geography of Water IP Seminars (for the contribution in the proceedings, see the references).

No	Year	University	Padova contributions: research and poster presentations
1	1994	Padova	**Faggi P.** Irrigazione, produzione territoriale e Stato nei PVS (proceedings) **Bertoncin M.** Il Delta del Po: scenari possibili di una terra di nessuno (proceedings) **Bicciato F.** Stato e privatizzazione nella gezira sudanese (proceedings) **Pase A.** Acqua e definizione di identità territoriale dello Stato: il caso sudanese (proceedings) **Croce D.** Con i giovani e per i giovani (proceedings)
2	1995	St. Etienne	**Bertoncin M.** La foce del non-senso: lo stato e il delta (proceedings) **Bicciato F.** Fog as a water resource for development in the Arequipa coastal desert (Peru) (proceedings) **Cavallet L.** Venezia e il suo entroterra: il caso particolare del "retratto di Monselice" (proceedings) **Al Hayati O.** Drought and its territorial impact in eastern Sudan's hills (proceedings) **De Fanis M.** Iconografie d'acqua nelle regioni nord adriatiche del primo novecento (proceedings) **Minoia P.** Territorialità idraulica nella regione del nord in Sudan: dall'acqua per la società all'acqua per lo stato (proceedings)
3	1996	London	**Faggi P.** Water in developing countries: productive and strategic values (proceedings) **Al Hayati O.** Rainfall in Sudan: actual perception and local forecasting (additional topic abstract)
4	1999	Cagliari	**Bertoncin M.** Geography and education (proceedings – educational method) **Faggi P.** The research activity on the geography of water in the Department of Geography, University of Padova (proceedings) **Lorena R.** "Adottiamo l'acqua" (proceedings) **De Marchi M.** Water and environmental conflicts behind the rhetoric of scarcity: environmental conflicts and conflict environments (proceedings)
5	2000	Linköping	No data
6	2001	Mainz	No data
7	2003	Praha	No data

[1] Pierpaolo Faggi interview on 23 April 2014.

No	Year	University	Padova contributions: research and poster presentations
8	2004	Pecs	No data
9	2005	Tartu (Fig. 1)	*Publications by students:* **Ariano S., Giacomini L., Pezzullo L., Vanzo E.** Man, environment and risk **Ariano S.** Uses of wetlands in the Senegal river delta **Ninfo A., Piovan S.** Methodologies in a geomorphological approach: examples from the Po Plain of Venice **Vanzo E.** Soil and water conservation techniques in Burkina Faso
10	2006	Seville	No data
11	2008	Sofia	**De Marchi M.** Tools for managing comprehensive water and environmental security: multi-track diplomacy (MTD) and peace and conflict impact assessment (PCIA) (proceedings)
12	2009	Udine	**Ariano S., Carestiato N.** Un territorio tra terra e mare: la laguna di Marano. Attività, attori, conflitti in un ecosistema fragile (proceedings) **Brusarosco A., Rossato S.** The Tagliamento riverbasin. “Don't divorce the river from its Basin” (proceedings - workshop report). **De Marchi M.** Water and Security in the Context of Climate Change (proceedings) **Maritan M.** The Lagoon of Marano and Grado (proceedings – workshop report). **Sauro U.** Karst landscapes and geosystems: some case studies in northeastern Italy (proceedings)
13	2010	Cluj Napoca	**Piovan S.** Palaeohydrography of late Holocene Adige-Po plain (Italy) (poster) **Pappalardo E.S.** Biodiversity conservation strategies and water conflicts in and around the YasunÍ Biosphere Reserve of the Ecuadorean Amazon Region (proceedings)
14	2011	Cagliari	**Piovan S.** Examples of an interdisciplinary approach: case studies from late Holocene man-environment interaction in the Adige-Po plain (Italy) (proceedings) **Donadelli G.** Education and teachers’ beliefs impact on climate change (proceedings)
15	2012	Munich	**Piovan S.** Late Holocene palaeohydrographical evolution in the southern Venetian Plain *(oral presentation)* **Vergara M.** Relationship between water and military events (poster)
16	2013	Zadar	**Piovan S.** Venetian Plain, Lagoon and Po Delta. Recognizing natural and cultural heritage related to the water management also by means of historical cartography (oral presentation) **Bonati S.** Flood risks in coastal areas. Hazardscape in Cinque Terre Unesco site (poster) **Cirillo D.** Large scale land acquisitions: from theory to African fields (poster) **Geronta C.** Water consumption and management in tourist destinations: the case study of the island of Rhodes (poster)

Figure 1. The Erasmus scholars from the Department of Geography of Padova at the 9th Seminar on Geography of Water, Tartu, Estonia. From the top-left: Silvia Piovan, Elisa Vanzo, Sara Ariano, Andrea Ninfo, Nadia Carestiato, Grazia Zuliani, Massimo De Marchi.

4. Erasmus IP on the geography of water 2014

After 20 years, the 2014 IP Seminar on Geography of Water will come back to the University of Padova. The 2014 Seminar will focus on the Geo-historical Evolution of the Waters in the Southern Venetian Plain. The Seminar will be primarily aimed at driving the attendants into an interdisciplinary, multi-scalar and diachronical approach to research the historical evolution of the relationships between man and waters in the southern Venetian Plain. The participants will deepen their knowledge on the complex man-water relationships at both an urban scale (i.e. Padova city) and in a wider regional scale (i.e. the alluvial plain between the Adige and Po rivers and the Po Delta region). In particular, the issues of land reclamation, river management, flood risk, territorial conflicts in a park, urban canal navigability, sustainable tourism on water, and exploitation of landmarks related to the waters for the valorization of the territory will be addressed.

Students will have the opportunity to pursue the following themes:

- to recognize the stakeholders that act in the territory and their concerns, and to participate in an interactive discussion with the stakeholders on the economical and political water-related conflicts.
- to study the historical evolution in rivers, canals and wetlands, methods of water control and flood mitigation, and to make a diachronical comparison of historical water management to present-day water control systems.

- to propose and rank criteria representing the water-related elements of natural and cultural heritages for a sustainable tourism.

Seminar activities will include lectures, field trips, interviews with stakeholders, discussion forums, and analysis of historical maps. Students will also have the opportunity to use a Geographic Information System (GIS) and Global Positioning System (GPS) with their smartphone to collect data, design cartographic visualizations, and analyse spatial relationships.

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Current paradigms in the management of water: Resulting information needs

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Water management goals, methodologies, conceptual approaches and institutional frameworks have evolved significantly over the past 30 years. These transformations have been stimulated by the promotion of the Integrated Water Resources Management (IWRM) paradigm by experts, academics, managers and international institutions. However, the application of IWRM faces resistance from defenders of the previously dominating infrastructural and resource-oriented hydraulic paradigm. It is also challenged by the contradictions and limitations that emerge from the practical experiences in its implementation at different scales. From a general perspective, criticism against the hydraulic paradigm and the emergence and consolidation of IWRM can be understood as being a part, in the water policy arena, of the historical shift from the post-war Keynesian regulation model to the current neo-liberal globalization system or, in more specific terms, from the "administrative rationalism" stage to the current "neo-privatization" trend. Increasing attention is being paid to the potential interconnections between the encouragement of water governance, a central focus of the IWRM approach, with wider global socio-economic processes that challenge existing democratic institutions. The wider hegemonic economic thought in which IWRM prescriptions are integrated, particularly the commodification processes and monetary reductionism of natural resources and the preeminence of the river basin as the natural scale for water resources management, is also coming under scrutiny.

From an epistemological perspective, the traditional separation of social and natural sciences has ignored the overlap of both fields of knowledge, which results in the limited theoretical and methodological development for their joint analysis, as well as the paucity of available data for management. The consideration of water as a socio-ecological patrimony requires linking biophysical and socioeconomic variables, a significant challenge given the current knowledge and modeling capabilities. There is a strong need for information on the complexity of socio-hydrological systems, which are reflexive, adaptive, non-linear and complex, and have feed-back loops, emerging properties and non-predictable responses to management interventions. In the context of the evolving paradigm for water management the recognition of these knowledge limitations are of vital importance.

1. Introduction

Water management goals, methodologies, conceptual approaches and institutional frameworks (actors involved, legal contexts) have evolved significantly over the past 30 years. These transformations have been stimulated by the promotion of the Integrated Water Resources Management (IWRM) paradigm by experts, academics, managers and international lending institutions, since the approval of the Dublin Statement on Water and Sustainable Development (Dublin Principles) at the 1992 International Conference on Water and

Environment. This long lasting process of paradigm change and consolidation is the manifestation, in the water resources field, of a wider and deeply contentious transformation in the way we currently understand society-nature interactions and the management of natural resources.

In practice, the application of IWRM has met with significant resistance from both the dominant values and interests of previous management approaches as well as growing criticisms from new theoretical and applied perspectives. The current water management landscape is dynamic and heterogeneous and its evolution cannot be described in a linear way. There is a distinctive hegemony of IWRM principles in discursive terms, even in countries like Spain where the hydraulic paradigm has been dominant until very recently. But this hegemonic position of IWRM is challenged by pervasive reminiscences of traditional, infrastructural and resource oriented tendencies, on the one hand, and emergent criticism from new perspectives, rooted in current visions of complexity, risk and social insecurity, on the other. In general, the diverse water management institutional frameworks that exist in practice reflect to different degrees elements of these different origins.

In this context of change and transformation it becomes relevant to reflect upon the new information and knowledge requirements for natural resources management in general and water management in particular. These requirements are conditioned by the growing opportunities provided by polycentric and changing loci of data generation; the different avenues for dissemination of existing information in an era of rapidly evolving information technologies; the promotion of public policies and legislation that enhance the dissemination, harmonization and reutilization of publicly produced information; and the growing demands for transparency and knowledge in natural resources management from increasingly demanding and critical social actors.

2. A new paradigm for water resources management

The hegemonic water management paradigm during most of the twentieth century in much of the western world emphasized resource development in order to expand supply to meet (while also encouraging) increasing demand, through the public planning and funding of hydraulic infrastructures. This approach, known as the *hydraulic paradigm* or *hydraulic mission* has been well described in different contexts, mainly in bio-geographical regions affected by aridity (see Allan, 1999 and 2006; Faggi, 1996; Feitelson, 1996; Del Moral and Sauri, 1999; Reisner, 1986; Swyngedouw, 1999; Hutchinson, Varady, and Drake, 2010). It entailed a project for the transformation of arid landscapes, characterised by drought and barrenness, and the resulting socioeconomic under-development and lack of growth. The privileged instrument behind this project for physical and social transformation would be hydraulic works funded with public money, in the all too frequent case that private initiative were not in a position to take on the risks of investment. Under this paradigm, scientific and technical expertise frequently supported dominating socio-political structures and cultural values to identify existing problems and propose solutions through rigid management plans with little room for adaptation, uncertainty or public participation. Two basic certainties encompassed in this vision are that Nature can be controlled and that the State, its development agencies, irrigators, power generators, etc., were engaged in essential and appropriate activities of public interest. The uni-functional ('build') and uni-disciplinary ('engineering') bureaucracy adopted a command-and-control philosophy, seeing users as subjects (and the State the provider) rather than active agents. This project seized both liberal western economies as well as the centrally planned economies of the Soviet Union. The hydraulic mission proved to be readily exportable to the global South in the second half of the 20th century.

As a reaction to this, over the past three decades there has been a substantial shift in the conceptual framework for water resources management, albeit with significant inertias from the past, and strong contradictions and substantial geographical differences in its implementation. The *post-hydraulic paradigm* has at its core the promotion of *demand management* approaches, the introduction of *economic incentives* for rationalization of water management and use, the conservation and restoration of *aquatic ecosystems*, and the *incorporation of stakeholders and the wider public in decision-making processes*.

These are common characteristics of a management approach that is widely known as Integrated Water Resources Management (IWRM), and has received significant attention from academics, managers and international funding institutions. In fact, the Global Water Partnership (GWP) was created in 1996 by the World Bank, the United Nations Development Programme (UNDP), and the Swedish International Development Cooperation Agency (SIDA) as an international network to foster IWRM as a way to achieve sustainable development. The GWP states that 'IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare, paving the way towards sustainable development, in an equitable manner without compromising the sustainability of vital ecosystems" (Global Water Partnership, 2000, 22).

However, as some of its recent critics argue, IWRM has been promoted as the "panacea" to resolve water management problems worldwide, and inspired national water resources legislation in different parts of the world—the South African National Water Act (NWA) of 1998, the 2000 Water Framework Directive (WFD) in the European Union or the 2004 Australian Intergovernmental Agreement on a National Water Initiative (NWI), to name just a few. From a general perspective, criticism against the hydraulic paradigm and the emergence and consolidation of IWRM can be understood as being a part, inside the particular water policy arena, of a whole historical shift from the post-war Keynesian regulation model to the current neo-liberal globalization system (Raco, 2013) or, in more specific terms, from the "administrative rationalism" stage to the current "neo-privatization" trend (Castro, 2011, Swyngedouw, 2007).

In the United States, the concept of IWRM is strongly established and even gaining considerable traction now. The United States Army Corps of Engineers (USACE) launched in February 2013 an on-line Federal Support Toolbox to provide Integrated Water Resources Management information[2]. The toolbox responds in part to the publication in 2010 of a National Report entitled *Responding to National Water Resources Challenges*, the result of a nationwide assessment process of water resources issues in the US facilitated by the USACE which established as a goal the need to "promulgate policies, concepts, and clear and consistent definitions that support IWRM" (USACE, 2010). Additionally, the American Water Resources Association (AWRA), a leading association for water managers and researchers in North America, adopted a Policy Statement in 2011 recommending that "water management goals, policies, programs and plans be organized around the concept of IWRM" and has organized two Summer Specialty conferences on this topic (Snowbird, 2011, Reno, June 2014).

IWRM is also the reference used by the SWAN project[3] as the starting point and initial framework for its scientific endeavors. However, building on concrete experiences in different parts of the world, over the past few years a growing debate has emerged questioning the

[2] www.watertoolbox.us

[3] SWAN: Sustainable Water ActioN: building research links between EU and US, FP7-INCO-2011-294947. https://swanproject.arizona.edu/

limitations, contradictions and conflicts that the integrated management paradigm finds in its practical implementation. In its 2011 policy statement, the American Water Resources Association (AWRA) recognized these limitations by stating that: "IWRM suffers from a lack of clear definition, the lack of standard measures to track the success of IWRM plans and projects, and the absence of guidance for those involved in planning and project development". From an applied perspective, for instance, Giordano and Shah (2013) discuss several examples in Asia and Africa where international lending institutions pushed for the approval of water policies aligned with IWRM, with mixed results. From a more theoretical standpoint, Molle (2009) is critical with the status of "nirvana" concept of the IWRM prescriptions, while Pahl-Wostl *et al.* (2012) question the possibility of existing "panaceas".

Some advanced formulations of IWRM, as the European Water Framework Directive (Directive 2000/60/EC), advocate for the incorporation of a wide range of areas of expertise and opinions through the entire decision-making process: from problem identification and development of alternatives, to the implementation of solutions (WFD, 1st consideration). However, from a critical perspective increasing attention is paid to the potential interconnection between the encouragement of *water governance* approaches with wider global socio-economic processes that question current democratic institutions and *devolve* power toward higher (EU, WTO, IMF, etc.) or lower institutional levels (NGOs, municipalities, etc.) (Heynen *et al*., 2007; Swyngendow, 2011).

The preeminence of the river basin as the *natural* scale for water resources management (Mostert *et al.,* 2008), a central focus of the IWRM approach, is also coming under scrutiny. In the context of the complexity of socio-hydrological systems, the debate about *spatial fit* or the definition of adequate physical and institutional boundaries becomes particularly relevant. The delimitation of management boundaries exclusively in physical terms does not sufficiently recognize the existence of the multiple geographies—political, socioeconomic, cultural—of socio-ecological systems (Van Meerkeert *et al.,* 2013). Critics acknowledge the undeniable and significant physiographic characteristics of the watershed, but also argue that there is no *natural* hydrologic scale that cannot be technically challenged. Authors such as Budds and Hinojosa (2012); Cohen and Davidson (2011); Del Moral and D'O (2014); Molle (2009), or Moss (2012), point to the diversity, ambiguity and lack of commonality of the different phenomenon that are used to define the watershed: micro and macro-watersheds or river basins, sub-basins, administrative boundaries, overlapping surface and groundwater boundaries, etc. Additionally, their lack of coincidence with existing institutional and socio-cultural boundaries further complicate the traditional challenges of operational coordination with key sectoral policies such as agriculture, environmental and natural resources policy, or regional and urban land use planning, to name just a few.

In this context, new and complementary management approaches are being proposed that aim to reinforce existing management prescriptions and more explicitly incorporate the concepts of hybridity between the social and the natural (*waterscapes*), complexity and uncertainty that underlie the new water management paradigm. Socio-ecosystem based management, polycentric governance (Ostrom and Cox, 2010), eco-adaptive management (Huitema *et al*., 2009), or the emerging concept of water security (Cook and Bakker, 2012; Staddon and James, 2012; Martínez Cortina *et al.,* 2010) are only some of the new or revised concepts that are gaining traction. Pahl-Wostl *et al.* (2011) argue that water management requires a further evolution along different axis:

- From central control to poly-centric governance, where the definition of the problems, the alternatives and the solutions are the result of a *cooperative* process between different actors and management centers;

- From prescriptive solutions to adaptive management approaches that facilitate learning and *adaptation* to a changing reality and to evolving understandings of the problem;
- From separate approaches to discrete environmental problems toward a comprehensive approach that transcends disciplines, geographical and professional boundaries, and areas of expertise.

3. The emergence of the water security concept

In the context of these debates, it is unavoidable to make a specific reference to the notion of water security. As Cook and Bakker (2012) point out, over the last decade the water security concept has emerged from its original niche in studies of international security and hydropolitics to become much more widely used. To some extent it seems even to be supplanting the hegemonic position hitherto occupied by the "sustainable water" concept (Staddon and James, 2012). According to these authors, UNESCO defines water security as a concept that "involves protection of vulnerable water systems, protection against water related hazards such as floods and droughts, sustainable development of water resources and safeguarding access to water functions and services" (Staddon and James, 2012, 2). The above definition subsumes key ideas of the "sustainable water management" paradigm as constitutive definitional elements whilst also importing the ideas of ecosystem functions and services, the risk of climate-related hydrological hazards, and water as an object of geopolitical security discourse. The idea of water security assumes that people's fundamental interests are in satisfying demands for water-related services such as food, fibre, waste disposal and sanitation. Thus, society's focus is not on the use of water per se but on the services and benefits provided per unit of water used (Martínez Cortina *et al.,* 2011).

Staddon and James (2012) point out that the gradual shift from 'sustainability' to 'security' implies continuing a course of action understood to be working (i.e. towards sustainable water use), but also incorporating a recognition of a widening and deepening urgency. Water security is counter-posed to the implied (and undesirable) outcome of water insecurity: a state of unreliable supplies of water of acceptable quality. Water security is centrally concerned with the potential risks both in terms of rights to water and threats that exist from external factors (which may be human or non-human) over water. While the sustainability discourse recognizes the possibility of "running out", it nevertheless tends to constitute itself in terms of the achieve ment of an ecological balance. The security discourse, by contrast, is based more on threats than opportunities and therefore tends to define the policy options negatively; policies that will prevent sub-optimal outcomes as much as those that will broker optimal ones.

More than a decade ago Ulrich Beck, although from another perspective, had envisioned the general context in which water security can be framed. Developing his notion of global risk society long before the credit crunch of 2008 and the austerity agendas that have followed, he stated that "collective life patterns, progress and control capacity, full employment and exploitation of nature typical of the first modernity, have been undermined by five interrelated processes: globalisation, individualisation, gender revolution, underemployment and global risks (such as the ecological crisis and the collapse of global financial markets). The real political and theoretical challenge of the second modernity is the fact that society must simultaneously meet all these challenges" (Beck, 1999, 2).

4. What are the new information requirements in the evolving water management paradigm?

Traditional water management focused on the procurement of new water resources to meet demand. Data requirements were therefore limited and focused primarily on quantitative estimates of available resources and consumption, as well as chemical water quality parameters insofar as chemical pollution may affect existing uses. Furthermore, economic information was limited to basic budgetary estimations for planned investments since cost recovery, when it existed, was limited to fairly narrowly defined water use levies and fees.

The increasingly dominating water management paradigm recognizes the complex and multifaceted nature of water and therefore has additional information requirements that can be summarized as follows:

- *Environmental information* and, more specifically, information on biological as well as chemical quality of water resources and associated aquatic ecosystems, in order to respond to new ecosystem-based management goals.
- *Socioeconomic information*, which becomes essential in the transition from a technocratic management approach with centralized and hierarchical decision making processes, where social actors are recipients of management decisions, toward more participative decision processes, a part of a new management culture that incorporates institutional learning and adaptation.
- *Economic information* on the costs of water services and associated prices, but accounting for the multifunctional characteristics of water from which multiple ecosystem services derive. That is, the economic information must take into account not only the financial costs of service provision, but also the ecosystemic implications of these services and the associated costs (environmental and resource costs, in the language of the WFD).
- Development of *synthetic and sustainability indicators*: the wealth of data available makes it necessary to develop indicators that present this information in a manner that is concise, agreed upon and easily understood, in order to facilitate continuous monitoring and evaluation of these complex socio-ecological systems. However, as Garnåsjordet et. al (2012) point out, these indicators comprise not only a selection of facts in some technical sense. The choices involved in the development of the indicators are subjective and respond to underlying "narratives" that are conditioned by societal interests and implicit values embedded in the data-generating processes. Therefore, the development of the data and assessments needs to be deliberated in a political process reaching agreements for political action.

5. In the context of the new requirements, what are the main deficiencies of currently available information for water resources management?

The primary limitations of currently available data and information are those that derive from the need to overcome the *nature-society dualism* that still is at the core of the hydraulic management paradigm. There is a strong need for information on the complexity of *socio-hydrological systems*, which are reflexive, adaptive, non-linear and complex, and have feed-back loops, emerging properties and non-predictable responses to management interventions.

The consideration of water as a socio-ecological patrimony requires linking biophysical and socioeconomic variables, a significant challenge given current knowledge and modeling capabilities. The traditional separation of social and natural sciences has ignored the overlap of both fields of knowledge, which results in the limited theoretical and methodological development for their joint analysis, as well as the paucity of available data for management.

There are significant gaps in knowledge in what refers to the efficacy of the measures implemented to improve the health of aquatic ecosystems. Current research in integrative analysis and inter-disciplinary modeling is producing increasingly robust information and knowledge, but the diversity and complexity of natural ecosystems impose significant restrictions on the transferability of the results from one spatially defined case to another.

These limitations in the understanding of the functioning of biophysical systems and their responses to management interventions also apply to the social dimension of socio-hydrological systems. As a result, attempts to precisely value the components of these systems, their functioning and interrelations do not seem feasible. Information and data need to be presented in a transparent manner, specifying their origin and the limitations and uncertainties they necessarily incorporate.

6. How can we manage the uncertainty associated with our understanding of socio-natural processes and its influence on resource availability and hydrological risks?

The concept of uncertainty can be understood under three different perspectives (Wynne, 1992):

- *Technical* (or conventional) *uncertainty* which refers to the unavailability of data and, more generally, information and knowledge. In this case the problem is related to the lack of reliability or thoroughness of the historical data, a frequent situation in hydrology. In order to overcome this problem scientists develop models, thus simplifying complexity. Some of the uncertainties related to the hydrological inverse methods (hydrological modeling) are those associated with: (1) model parameter estimates and (2) model parameter resolution (see Vasco *et al.*, 1997) or, more importantly, (3) model structural uncertainty (completeness / adequacy) (Gupta and Nearing, 2014; Gupta *et al.*, 2012, and Gupta *et al.*, 2008).
- Uncertainty in terms of *indetermination.* In these situations the system parameters and their interrelationships are unknown, since they are so complex, and consequently the model results become completely unreliable.
- Uncertainty in terms of *ignorance,* which occurs when 'we ignore what we do not know'.

In the context of the evolving paradigm for water management these knowledge limitations are of vital importance: we recognize that uncertainty is inevitable when dealing with socio-ecological systems. We must therefore strive to understand its relevance in the system we are studying and, to the extent possible, identify the potential fluctuations and their repercussions on the rest of the system being modelled. The need to adequately manage uncertainty in complex systems is the most relevant factor, in an epistemological sense, which demands multi-disciplinary approaches and the participation of a diversity of actors and interests in decision-making processes.

7. Some final remarks and questions for further discussion

(1) IWRM is the dominating paradigm for sustainable water management today. The Water Framework Directive represents perhaps the most ambitious and complex legal effort to put the principles of IWRM into practice in the EU’s member states. Other national legislations

also incorporate IWRM prescriptions. However, this model faces resistance from the previously dominating hydraulic paradigm, as well as the contradictions that emerge from the practical experiences in its implementation at different scales (from regional to global). The criticisms that it has received in the recent past focus on the following main aspects:

- The river basin as the undisputed scale for integrated management and water governance. While it may be the ideal scale of hydrologic characterization, its appropriateness as the ideal scale for governance is under dispute.
- The larger hegemonic economic thought in which IWRM prescriptions are integrated, particularly the commodification processes and monetary reductionism of natural resources.
- The weaknesses and failures of public participation processes that have accompanied actual water resources planning and management experiences and that are an integral part of the IWRM theoretical framework.

(2) Water management today presents significant information challenges. Information must simultaneously fulfill requirements that are to some degree opposed and antagonistic but also mutually necessary, in close interaction with one another or, as Edgar Morin would say, *dialogically* related (see Morin, 1977, 80).

- Information versus data;
- Information needed to improve management versus information dissemination to improve transparency and facilitate public participation;
- Real versus modelled data;
- Quantitative versus qualitative data;
- Real time versus delayed data;
- Physical versus socioeconomic data;
- Conventional network versus new networks (remote sensing, etc.) data.

(3) The profound paradigm shift in water management has had important implications for information and data requirements. The transition from the promotion of hydraulic infrastructures as the primary water policy goal to economic and ecosystem-based water management, and the recognition of water as a patrimony has required not only new information, but also new methodologies for gathering and generating this information. Some of the main new debates about the limitations and insufficiencies of the now discursively dominant of IWRM paradigm revolve around the following issues:

- Estimating the costs associated with ecosystem restoration is infinitely more complex than calculating the costs associated with water flows, since these can be simplified through the balance of the hydrologic cycle.
- The valuation of ecosystem services requires using metrics other than monetary valuation, as well as site-specific studies. The methodologies and information necessary for these valuations are still under development.
- The incorporation of the social dimension brings with it elements of complexity and uncertainty in addition to those inherent to natural systems. Therefore the understanding, representation and management of water as an eco-social patrimony poses new challenges that require information that is still being developed.

(4) The selection of the scale for water management has direct implications for information and data availability and requirements: local versus global scale for information gathering;

central planning (models) versus local planning (real network data). Related to this issue the next questions arise:

- What are the possibilities and real potential of different alternatives for information generation and what are the difficulties and challenges inherent to each choice?
- What are the institutional conditions for its implementation?
- Are public information systems organized to facilitate the knowledge generation and information exchanges or are there still important imbalances between the potential of the new ICTs and the individualistic behaviour that still dominates information management?

(5) Currently dominating water management models are also challenged by the use of fixed horizons and time scales. As with spatial scale, the problems and challenges in water management do not meet defined time limits. The elements of the hydro-social system, and thus the uncertainties, are temporarily changing and they entail problems with water risks and water resources that are non-stationary and that cannot be studied under a single temporal pattern. The availability of data and information on the system is also variable and the adaptation to this dynamic is imperative. In addition, water management necessarily requires the handling of a temporal dimension on which incomplete information is available: the future. It is necessary to develop dynamic scenarios without limiting the study to the already known system conditions.

(6) Too often in the final stages of decision making processes there is a *political externalization* of key final operational decisions. Water managers (or politics) impose decisions that are not coherent with scientific, integrated and participatory processes that precisely aim to understand, anticipate and direct sustainable management decisions. There is a lack of understanding about these informal decision making processes. Research about the links between science and politics must incorporate information about the factors that drive and help explain these fundamental mechanisms.

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Morphological assessment of the quality of running water bodies for water management planning

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The article compares methods of six EU countries and develops practical methods for the morphological assessment of Estonian rivers by taking into account the EU Water Framework Directive. The assessment is based on the physical parameters of watercourses and the methodology reflects their typological differences. Across the EU different methods are applied nationally for the purpose of hydromorphological status assessment of running water bodies. Many artificial and dredged water bodies in Estonia are registered in the Environmental Register as natural streams and rivers due to the lack of clear criteria and methods for calculating the morphological parameters. A specific aspect in Estonia is large beaver population. Beaver dams constructed on rivers and streams have an adverse effect on the hydromorphological status of watercourses. The hydromorphological features that should be taken into account in assessing the ecological status of rivers in the Estonian context, are flow regime, sinuosity, variability of width and depth, and the nature of buffer zones on the banks. Good integral indicator of the ecological status of watercourses is sinuosity index as it characterises distinctively the diversity of the biotopes suitable for the biota along the river channel. Based on the sinuosity factor, the Estonian rivers and reaches are classified into five classes.

1. Introduction

The ecological status of water bodies is determined by biological, physical-chemical and hydromorphological quality indicators. Besides biological quality indicators, hydrological, morphological and physical-chemical indicators are also considered to determine the ecological status of a water body in order to assess whether, and to what extent, human activity has affected the natural regime of the water body through those elements. Human activity has altered and is altering the natural status of rivers by damming, dredging, straightening, impounding and so forth.

The aim of this paper is to develop practical methods for the morphological assessment of Estonian rivers by taking into account the objectives laid down in the EU Water Framework Directive (WFD). Different methods have been suggested for assessing the hydromorphological status of watercourses but very few specific measures have been implemented in practical water management. There are almost no substantive assessments based on hydromorphological indicators because most assessments have been prepared on the basis of aquatic biota. If hydromorphological assessment criteria were applied, the result would probably be somewhat different.

2. Classification of watercourses

For the purposes of water management plans, surface water bodies are divided into natural, heavily modified and artificial water bodies. Heavily modified water bodies (HMWB) and artificial water bodies (AWB) are designated on the basis of on various guidelines and agreed methodology. For the final designation, all water bodies initially designated as heavily modified or artificial were divided into three groups based on the cause of modification or artificial nature of the water body: a) impounding, b) land reclamation, c) infrastructure.

Water use and types of physical alteration used to designate water bodies as heavily modified or artificial are specified in water management plans in accordance with Article 4(3) of the WFD. However, in the case of watercourses with a small river basin the designation of a water body as heavily modified or artificial requires the specification of artificial recipients created for the purpose of land reclamation. Many artificial and dredged water bodies are registered in the Estonian Environmental Register as streams and rivers and, therefore, they were designated as natural water bodies due to the lack of clear criteria and methods for calculating the morphological parameters. In the course of further specification, the share of water bodies classified as natural water bodies with a river basin under 100 km^2 is likely to decrease significantly.

In order to establish and designate surface water bodies, all watercourses with a catchment area over 10 km^2 are taken into account. The types of water bodies are described according to system B provided in Annex II to the WFD (Table 1). Therefore, the status class of Estonian natural watercourses is determined on the basis of the following two main characteristics:

a) morphological characteristic (the size of a river basin);
b) physical-chemical characteristic (the content of organic matter based on BOD (chemical oxygen demand)).

Table 1. Types of natural water bodies in Estonia.

Type	Description
IA	dark-coloured, humic substance-rich (COD_{Mn} 90% value above 25 mgO/l) rivers with a river basin of 10–100 km^2
IB	light-coloured rivers with a low content of organic matter (COD_{Mn} 90% value below 25 mgO/l) and a river basin of 10–100 km^2
IIA	dark-coloured, humic substance-rich (COD_{Mn} 90% value above 25 mgO/l) rivers with a river basin of >100–1000 km^2
IIB	light-coloured rivers with a low content of organic matter (COD_{Mn} 90% value below 25 mgO/l) and a river basin of >100–1000 km^2
IIIA	dark-coloured, humic substance-rich (COD_{Mn} 90% value above 25 mgO/l) rivers with a river basin of >1000–10,000 km^2
IIIB	light-coloured rivers with a low content of organic matter (COD_{Mn} 90% value below 25 mgO/l) and a river basin of >1000–10,000 km^2
IVB	rivers with a river basin area of more than 10,000 km^2 (the Narva river)

As regards optional factors, meteorological indicators (air temperature range, mean air temperature and precipitation) are not relevant in Estonia. Due to the small territory, the differences are marginal within Estonia and do not have any effect on the establishment of different types of water bodies. Chemical factors not relevant in Estonia are: the acid neutralising capacity and chloride content; the physical factor not relevant is the transport of suspended solids. The hydrographical indicator ‘distance from river source’ is used to define rivers by sections. The river discharge (flow) category is a factor characterising the discharge regime and using that factor would be justified. However, to use this factor, the hydrological regionalization of Estonia is required. Valley shape is a general geographical feature that has not been used in determining river types.

3. Overview of the hydromorphological assessment of watercourses in other countries

As regards choosing a method for the assessment of the hydromorphological condition of water bodies, it is appropriate to give a short overview of the surveys conducted in other EU member states. We have selected six countries for comparative analyses: Austria, Denmark, France, Germany, the United Kingdom and Slovakia. The main information about the characteristics used for the morphological assessment of running water bodies are presented in Table 2.

Table 2. Methods used in some European countries to assess the hydromorphological status of rivers.

Activity	Austria	Denmark	France	Germany	United Kingdom	Slovakia
Methodology						
Typological parameters	yes	yes	yes (no)	yes	yes	yes
Quality classes established	yes	no	yes	yes	yes	yes
Calculation of index	Simple sum	Weighted sum	Weighted sum	3 different methods	Simple sum	Mean
Fieldwork	yes	yes	yes	yes	yes	yes
GIS-based	yes	yes (no)	yes	yes	no	yes
Length of a surveyed section, m	?	100 m	100 m to few km	100 m or 1 km	500 m	200, 500, 1000 m
Width of a surveyed section, m	Floodplain	10 or 50 m	Floodplain	Floodplain	50 m	Floodplain
Surveyed unit	Longitudinal section, floodplain	Longitudinal section, floodplain, transect	Longitudinal section, floodplain	Longitudinal section, floodplain	Longitudinal section, floodplain, transect	Longitudinal section, floodplain
Implementation						
River size[1]	Big	Small	Small, medium-sized, large	Small, medium-sized, large	Small, medium-sized	Small, medium-sized, large
Morphology of river	Sinuous, branching	Meandering	Sinuous, branching	Sinuous, branching	Sinuous, branching	Sinuous, branching

Use of reference conditions and typology. The assessment is based on the physical parameters of watercourses and the methodology reflects their typological differences. Existing databases are used and some parameters are collected in the field. The determination of reference conditions is somewhat ambiguous. It is better to determine reference conditions by countries, rather than for Europe as a whole.

[1] Classification by size: 1) small – up to 10 m wide; 2) medium-sized – 10–30 m wide; 3) large – more than 30 m wide.

Determination of different types of river. The typology of rivers is inevitably based on the specific conditions of a country or a region for which the typology is developed. The typology is the narrowest in Denmark where only wadeable lowland streams with small or medium sinuosity are assessed. In Germany, two different systems are used to assess small and medium-sized streams and large rivers. The assessment method used in the UK is applied to both upland and lowland streams but only those that are wadeable. The systems developed in France and Austria are applied to both upland and lowland streams as well as to watercourses of all sizes. However, the assessment method depends on the morphology of a river and it is not clear how that method can be used for all types of rivers.

Length and width of a surveyed section. The length of a surveyed river section is fixed in the Danish and UK assessment systems, whereas the methods are designed primarily for wadeable rivers and focus mainly on the riverbed. Floodplains as important hydromorphological features are also surveyed. The length of a surveyed section is at least 100 m with small rivers and usually longer than 1 km with large rivers. Therefore, the length of a surveyed section depends directly on the size of the river. In Slovakia, for example, surveyed sections are divided into shorter parts in order to interpret the parameters of the riverbed and the morphology of the river. In Denmark, the description of the floodplain is limited to land use within the first 10 m of the riverbed (up to 50 m for larger rivers). Land use data and geomorphological data are recorded during fieldwork but not used in hydromorphological assessment.

Assessment. The UK and Danish methods are based on the data collected on sites in the course of fieldwork. Other methods require the use of maps, GIS layers or aerial photographs to assess the hydromorphological features; GIS-based typology is used in all assessment systems. Similarities exist between the different assessment systems and the parameters used, but there are also significant differences between the systems when it comes to assessing the parameters on site. The UK system is based on natural features and non-natural features are not taken into account. The values of all parameters are taken into account in the final assessment. According to the Danish method, all parameters are assessed based on their intensity. A four-point assessment scale is used and the parameters are assigned numeric values based on their importance. The index value is the sum of the values of individual parameters. The German and Slovakian systems are based on the same principles as the UK and Danish systems, although they are more complex. According to the German method, parameters are assigned points between 1 and 7 and, according to the Slovakian method, between 1 and 5. In the German system, a parameter may be assigned a different value depending on the type of the river; this means that natural differences in the morphology and size of the river are taken into account. The French system is also based on the difference in the importance of parameters.

Number of parameters. The number of parameters differs from country to country. The Danish system uses 20 parameters, only one of which is measured on site (river width). The UK system, on the other hand, uses 200 different parameters. The French and Austrian systems use hydrological parameters that describe the hydrological regime of the river and are based on discharge measurement data. The method designed for larger rivers also uses the information available on maps.

Floodplain assessment. Floodplains are assessed in the case of large rivers. This means that a riverine habitat covers both the riverbed and the surrounding landscape in the river valley. The biological value of a river depends on the connectivity between the riverbed and the river valley. The assessment of floodplains comprises the assessments of the vegetation structure and the artificial structures on the floodplain. In many cases, the information required for assessing floodplains, especially large areas, is obtained from maps. The data concerning floodplains is supplementary and is not used for the physical assessment of rivers.

Assessment of riverbanks. Bank features are best recorded in the field and the data collected is used to describe the natural erosion and accumulation patterns in the riverbed. In addition, the data on vegetation structure on banks and in the buffer zone is recorded. It is important to record information on artificial elements that have been used to reinforce the banks.

River shape. According to the German, Austrian and Slovakian methods, information about previously natural watercourses that have been directed into artificial channels is used to assess the changes. Old maps are used to obtain the required reference information. The Danish system does not use reference data concerning the shape but determines the sinuosity of rivers and the occurrence of rapids and pools with slow flow velocity.

Riverbed shape. The shape of the riverbed is assessed based on its cross-section. According to the Danish method, there are four cross-section types, ranging from natural to heavily modified. Such assessment is related to the depth parameter, which is the main parameter to assess changes in the cross-section of the riverbed. The variation of width is not relevant, although the Danish method measures the width of the river section in 10 cross-sections. The UK and German methods record the morphological features of the riverbed and the degree of variation subjectively.

Longitudinal connectivity. Changing structures of the riverbed that affect the flow regime and the movement of flora and fauna along the river are recorded in most cases. The assessment of these elements depends on the magnitude of their effect, and they are assigned negative values. In some cases, several parameters that influence the quality of flow are distinguished. These parameters are usually damming structures, diversion of water and impoundment.

Hydrological regime. Austria and France use directly measurable parameters that indicate the hydrological regime. These countries use the data of long-term hydrological monitoring that characterises the rivers of the specific region. Germany and Slovakia use the parameters of hydrological variability determined in the course of fieldwork and the information received from landowners. Slovakia also collects hydrological data to determine the amount of impounded water. The UK uses indirect assessment to identify floodplain-related changes in the hydrological regime. Denmark does not assess hydrological pressure; although changes in the buffer zone are recorded, they are not used in the final assessment.

4. Standard EVS-EN 15843:2010 Water quality – Guidance standard on determining the degree of modification of river hydromorphology

The standard provides guidance on the hydromorphological assessment of rivers by sections. According to the standard, mainly qualitative features are used but quantitative features are also taken into account if possible. The standard uses ten features that are divided into two groups: 1) core features and 2) subsidiary features. Core features are used to establish hydromorphological modifications, including the assessment of pressure factors. Subsidiary features are mainly used to assess the quality of habitats (Table 3).

Table 3 Standard "EVS-EN 15843:2010 Water quality – Guidance standard on determining the degree of modification of river hydromorphology" in the Koiva river basin in Estonia.

Parameter	Core feature	Subsidiary feature	Explanation in the context of the Koiva river basin district
1. Channel geometry			
1a) Planform	+		Assessed on the basis of the sinuosity factor
1b) Long-section and cross-section	+		What is important is the long-section; the differences in the cross-section are not considered because this requires an extensive special study
2. Substrates			
2a) Artificial material	+		In the Koiva river basin, the main impact is that of land reclamation
2b) Natural material		+	In the future, joining features 2a and 2b should be considered
3. Channel vegetation and organic debris			
3a) Aquatic vegetation management		+	Not considered in the Koiva river basin district
3b) Woody debris and floating debris		+	An important parameter in rivers with a smaller catchment area (less than 300–400 km^2)
4. Erosion/Deposition character			
		+	The intensity of the process can be assessed and distinguished by using the long-section
5. Flow			
5a) Artificial in-channel structures	+		Impounding dams, culverts
5b) Effects of catchment-wide modifications on natural flow character	+		No effects in the Koiva river basin district
5c) Effects of daily flow alteration	+		Hydropeaking
6. Longitudinl continuity as affected by artificial structures	+		Not present in the Koiva river basin district; single cases occurring elsewhere are accounted for under 5a
7. Bank structure	+		The composition of the bank material is taken into account
8. Vegetation type/structure on banks and adjacent land	+		Assessment of the area within the 10 m riparian zone through adjacent land-use
9. Adjacent land-use	+		Assessment of the area further than 10 m from the banks on the basis of maps
10. Channel-floodplain interactions			
10a) Degree of lateral connectivity of river and floodplain	+		In the Koiva river basin district, interactions exist in places where the channel is not artificial
10b) Degree of lateral movement of river channel	+		It is taken into account that in sections that flow in an artificial channel the channel processes are not natural

5. Indicators characterising watercourses in Estonia

The majority of the rivers in Estonia are small: short, narrow and shallow (not very deep). The width of river valleys varies between 20 metres and 0.5 kilometres. The slope of rivers varies greatly due to the natural formation of the relief forms. As regards aquatic biota, the main indicator of the size of a watercourse is river discharge. The latter is well characterised by the size of the catchment area. Although these two features are relatively well connected, there are still exceptions. Some sections of watercourses with a smaller catchment area are actually richer in water during low water periods than watercourses which have a significantly larger catchment area. River sections that are intensively fed from ground water, in particular those that originate from larger springs or springy lakes, have significantly greater discharge during the minimum runoff period. The EU WFD, however, prefers to characterise the size of a water body by the size of its catchment area. This is probably so for the sake of rationality because the size of the catchment area is easier to determine and calculate than the runoff characteristics.

Slope. Slope is the feature on the basis of which it is easiest to divide a river hydromorphologically into rhithral and potamal reaches. There is, however, a small problem – the slope of small rivers and streams changes rapidly along the river. Therefore, the data on the slope of reaches is somewhat generalised. It is considered practical (Järvekülg, 2003) that in small rivers and streams (with a catchment area of <100 km^2) the gradient is determined for sections of approximately 1 km (about 0.5 km upstream and downstream from the centre of a monitored section), in medium-sized rivers (with a catchment area of 100–1000 km^2) for sections of approximately 5 km, and in larger rivers (with a catchment area of >1000 km^2) for sections of approximately 10 km. The water level data necessary for determining the slope is available on topographic maps and digital LIDAR information.

Sinuosity. Sinuosity is considered a good integral indicator of the ecological status of watercourses because it quite clearly characterises the diversity of the biotopes suitable for the biota, including fish. Sinuosity can be determined on large-scale digital maps. In the Baltic ecological region, the most suitable scale is from 1:10,000 to 1:20,000. Old maps can be used to determine the sinuosity of rivers before modification, that is, their natural sinuosity before dredging and straightening.

Connectivity with other water bodies. The rivers, especially those flowing into the Baltic Sea and large lakes (L. Peipsi and L. Võrtsjärv), are more important for fisheries than other watercourses. Despite the fact that the fish in such rivers (reaches of river) are heavily influenced by lakes, the connectivity between such water bodies should be considered very important for aquatic biota. While the flow regime indicators (flow velocity in particular) are the main factors used in the typology of watercourses, connectivity with other water bodies is not even included in the optional factors.

Rivers are mainly fragmented by dams and occasionally by culverts that prevent fish from swimming upstream. Dams prevent fish from moving upstream to their spawning places and habitats. The construction of dams reduces the number of rapid reaches because rapids upstream from the dam (if there were any) are flooded. The factor that can be analysed is the share of impounded reaches (length of impounded reaches/length of the reach concerned) upstream from the dam.

Riverbed parameters. The slope, flow velocity and the naturalness of the river bottom are important factors for aquatic biota. Slope is critical, because flow velocity depends on it and the formation of riverbed sediments depend on flow velocity. The easiest way to account for the riverbed parameters is to divide reaches into rhithral and potamal according to the typology of watercourses. Rhithral reaches have more rapids and fast-flowing reaches and, therefore, coarser substrate (rocks or gravel) and less fine sediments (sand, mud, clay, peat) than potamal reaches. In fast-flowing rivers, the oxygen content of water is high, that is, 70–90% of the natural saturation degree, all year round. Only a few species of fish (freshwater trout, grayling, common minnow) who are strong swimmers and some benthic species (bullhead, stone loach) can live in very fast-flowing reaches, usually in the upper reaches. From the point of view of water researchers, a practical typology of rivers based on the slope, flow velocity and substrate nature would be the following:

- *a) rhithral rivers/reaches* with predominantly rapid and fast-flowing water and rocky-gravel bottom; there are no slow-flowing reaches with soft sediments or their number is so small that they do not limit the diversity of fish species or the number of fish;
- *b) potamal rivers/reaches* with predominantly slow-flowing water and soft sediments; there are no fast-flowing reaches with rapids and rocky-gravel bottom or their number is so small that they do not affect the diversity of fish species or the number of fish;
- *c) rivers/reaches of alternating nature* – a large number of both rhithral and potamal reaches, neither of which has a direct dominating effect on the diversity and number of fish.

Flow velocity. As regards hydromorphology and hydrochemistry, Estonian experts have agreed that the mean flow velocity of 0.2 m/s is the line that distinguishes fast flow from slow flow. The usual flow velocity of Estonian rivers is 0.1–0.2 m/s in low water periods and 0.5–0.8 m/s in high water periods. Rock and other obstacles at the bottom of a river as well as bank projections often cause alternating and uneven flow rates in the river channel. According to P. Eloranta (1992), the main types of substrate at the following flow velocities are:

Flow velocity, m/s	Type of substrate
>1.0	rocky;
0.5–1.0	rocky-gravel;
0.25–0.5	gravel-sandy;
0.1–0.25	fine sandy;
<0.10	muddy or clayey (also sandy).

Flow velocity has not been used directly in the assessment of river channels. It varies significantly depending on slope and river discharge. During flood periods, flow velocity is high and rivers carry large amounts of sediments, changing the shape of the channel. It is recommended to use a slope instead of flow velocity because the slope is easily determined, expressed also in numerical value and reflects directly flow velocity. In general, the boundary between high and low velocities in Estonian watercourses is 0.25 m/s. As regards low velocity (less than 0.25 m/s), it is appropriate to distinguish between low and very low velocity (less than 0.1 m/s). Very low velocity occurs mainly in rivers and streams with fine bottom sediments, including clay.

Floodplain. The expert opinion is prepared on the existence of flood meadows and the extent to which these meadows are flooded during high water. The assessment is based on map information (Estonian soil map, historical maps). In Estonia, it is appropriate to determine whether there are abandoned meanders, secondary river arms and oxbows in addition to flood meadows. Since virtually all floodplains in Estonia have a natural water regime, there is no need to take this factor into account in hydromorphological assessment.

Banks. The assessment of the banks of watercourses is twofold:

a) the part of the river channel affected by flowing water and formed according to the channel material, flow velocity and channel configuration;

b) the bank adjacent to the river channel; usually above the water level.

The latter is considered to be a buffer zone that offers various habitats for flora and fauna and acts as a barrier to diffuse pollution from the catchment area. Without a buffer zone, banks can become unstable, which may cause additional erosion. Many Estonian rivers have been straightened and dredged as a result of land reclamation and, therefore, there is no buffer zone between the banks of watercourses and arable land. In the assessment of watercourses, the width and status of the buffer zone can be based on the dimensions of water protection zones laid down in the Water Act. The width of water protection zone of water bodies in Estonia is determined from 1 m to 20 m. For good quality, at least 80% of the riverbanks must be natural.

Runoff regime. River discharge in different seasons (water regime) varies and mainly depends on the climate and the type of source from which the river is fed. In general, the division of the runoff of Estonian rivers by recharge sources (snow melt water, rainwater and ground water) is very even – the share of each recharge source is 1/3 of the runoff. There are, however, smaller rivers in Estonia for which the importance of groundwater as a recharge source is greater than average.

The minimum runoff during low water periods does not often ensure a sufficient amount of water for fish. The ecological status of the river also depends on it. The often virtually non-existent amount of water during low water periods does not reduce the impact of pollution from effluent and this may worsen the condition of the ecosystem. The average river discharge (in the directive: river discharge (flow) category) is important in the case of fish but the limiting factor is the minimum discharge during low water periods, in particular discharge during summer low waters. In order to determine river discharge during low water periods, hydrological calculations are required.

Temperature regime of watercourses. The temperature regime of a water body is one of those natural factors that determine the ecological conditions of water body, and the diversity, composition and number of different species. In the case of Estonian watercourses, the following classification based on the daily mean water temperature should be used:

- *Cold and cool water rivers/reaches.* Maximum water temperature <18°C; mainly cold-loving and eurythermal species of fish; there are no warmth-loving species.
- *Temperate water rivers/reaches.* Maximum water temperature 18–22°Cin summer; cold-loving and eurythermal species of fish as well as some warmth-loving species.
- *Warm water rivers/reaches.* Maximum water temperature in summer >22°C; there are no cold-water species as a rule; mainly eurythermal and warmth-loving species of fish.

6. Sinuosity as an integral morphological feature

A river's sinuosity is the degree of deviation from the direct path of a channel or a wider valley. According to Rosgen (1994), sinuosity is a secondary morphological feature that characterises the channel and flow conditions, rather than the environment surrounding a river. More specifically, we can look at trajectory sinuosity of stronger (faster) flow, that is, the main flow from one cut bank to another, and so forth.

The sinuosity of a given reach is usually expressed by the sinuosity index that is defined as the ratio of the curvilinear length (along the curve) and the distance (straight line) between the end points of the curve. Therefore, a reach that flows directly downslope has a sinuosity index of 1, and the more meandering the river, the greater sinuosity index it has. Natural river channels that flow in a straight line for a distance of more than ten channel widths are very rare. However, reaches that deviate from a straight line relatively little and have a small sinuosity index – about 1.1 (Schumm, 1963) or nearly 1.2 (Rosgen) – are sometimes described as straight.

In general, meandering rivers can be divided into rivers with a relatively stable channel and actively meandering rivers. Leopold and Wolman (1957) have suggested that river channels with sinuosity greater than 1.5 are defined as meandering; this value is chosen a little arbitrarily but it has also been referred to by other experts (e.g., Razlaff 1991). Schumm (1963) has divided river channels that are classified as meandering according to the division of alluvial rivers into regular, irregular and tortuous. Rather than forming a more or less straight line or a smooth curve, the meanders of an irregular channel are directed alternately towards one or the other bank. Each has a sinuosity index of nearly 2. River reaches that have many small meanders can be classified individually as tortuous. In general, they have a sinuosity index of over 2. River reaches that have a smaller sinuosity index are classified as transitional or straight. Transitional reaches have relatively straight meanders and a smaller sinuosity index (about 1.3). Straight reaches can bend slightly, yet not at regular intervals.

Determining the sinuosity factor. The sinuosity of watercourses in terms of its numerical value is determined by using the sinuosity factor L. In order to calculate the sinuosity of a river, the latter is divided into reaches and the length of the straight line between the end points of the curve P_s and the length of each reach P_l is measured. The sinuosity of a reach is calculated by using the following equation:

$$L = \frac{P_s}{P_l}$$

A river is divided into reaches so that in each reach the channel is within a more or less straight section of the valley. If the valley does not distinguish from the surrounding landscape, the river is flowing within an imaginary valley so that it is flowing in a straight corridor in the same direction. In order to ensure that reaches are not selected arbitrarily, an algorithm is used to determine reaches based on initial data and one parameter.

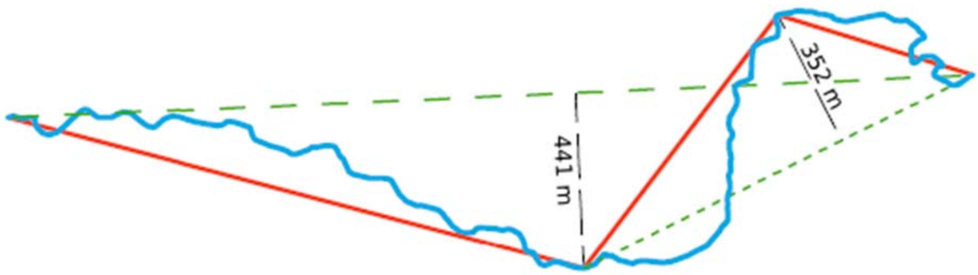

Figure 1. In order to divide the river into reaches, it was divided into two at the farthest point from the straight line connecting the headspring and the mouth of the river. The sections were further divided into two according to the same principle until there were no points that would be farther from the straight line connecting the end points of a reach than the predetermined value (300 metres in this study).

None of the points of the centre line of the river are farther than 300 metres from the straight line connecting the end points of a reach. In order to determine such sections, one of the two generalisation algorithms published by David and Thomas Peucker in 1973 was used. The application of the algorithm is illustrated in Figure 1. The only parameter used is the biggest allowable distance of reaches, that is, the found line from the starting point. Next, we will explain why the distance of 300 metres was chosen.

Different rounded values from 100 to 600 metres were used to find the maximum deviation and the results were compared on the map. Figure 2 illustrates the differences between a number of values. As the scale of the map of Estonia is 1:10,000 and the river shapes taken from the set of topographical data are on the same scale and have the same accuracy, the differences were compared on the big map.

The comparison of the maps showed that, if the deviation is just 100 metres, the resulting reaches could be used to calculate the sinuosity factor for single meanders or a couple of successive meanders. A deviation of 200 metres results in longer reaches but the overall result is similar to that of using a 100-metre deviation. A 500-metre deviation, on the other hand, results in reaches that characterize on a smaller scale map the changes in the direction of the river or the line connecting the end points remains outside the defined river valley. If a 400-metre deviation is used, the reaches are similar to those resulting from a 500-metre deviation. On the main map, the local differences in the direction of the valley or the flow seem to be most distinct if 300 m is used as the parameter of the generalisation algorithm. Therefore, smaller deviations result in unnecessarily large data sets and the sinuosity factors calculated by using bigger deviations do not effectively characterise the local differences of sinuosity.

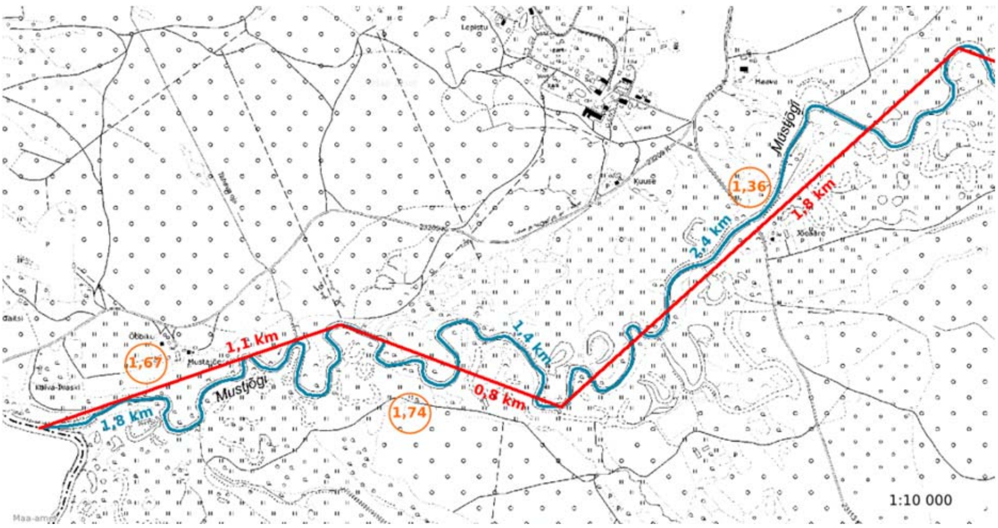

Figure 2. The Mustjõgi river mouth section before flowing into the Koivariver. The red line, the distance of which from the central line of the river is not greater than 300 metres, connects the end points of the reaches. The length of reaches and the reference line and the value of the sinuosity.

Classification of rivers according to the sinuosity factor. Based on the sinuosity factor, rivers and reaches are classified into five classes (Table 4) that are used to describe the sinuosity of the reaches. The classes are formed so that each consists of reaches of more or less the same size. As reaches of smaller sinuosity are overrepresented, the two classes that consist of lower values of the sinuosity factor are relatively close to each other. The upper limit of the class representing the reaches of smallest sinuosity is close to the lower quartile (about 1.05). As the sinuosity of the reaches in that class is barely noticeable on the map or they do not meander at all, let us call them conditionally *straight* reaches. In order to ensure that each following class is of about the same size, the upper limit is placed close to the median. In order to make the boundaries between classes easy to remember, the values are rounded to numbers that are divisible by five and ten and the boundary sinuosity factor is 1.10.

Table 4. Classification of reaches by the sinuosity factor in Estonia (Järvet and Jaanus, 2012).

Class	Description	Lower limit	Upper limit	Share %	No of reaches
V	Straight	1.00	1.05	26.1	1384
IV	Slightly meandering	1.05	1.10	18.6	984
III	Meandering	1.10	1.30	30.6	1619
II	Strongly meandering	1.30	1.50	13.5	717
I	Very strongly meandering	1.50	2.75	11.1	589

Let us call the reaches in the second class *slightly meandering.* The upper limit of the next class should be, based on the above, close to the upper quartile (i.e., 1.30 as rounded). As the lower limit for slightly meandering reaches was rounded down and the upper limit was rounded up, the third class (*meandering*) is the most numerous. The remaining quarter has the widest range of values. In order to distinguish between reaches of different sinuosity factors, the last quarter is divided into two. In order to ensure that the number of reaches in each class is similar, the limit of strongly meandering rivers is close to the upper decile, or 1.50 as rounded. The last two classes are called *strongly meandering* and *very strongly meandering.* Although the range of values in the last class is about two and a half times bigger than all other classes taken together, only a few reaches have a sinuosity factor that is close to the maximum (2.73). The sinuosity factor of 90% of very strongly meandering reaches is in the range of 1.5 to 2.0.

The total sinuosity of a river is calculated so that the sinuosity factor k_L is the weighted average of the sinuosity factors of all reaches, while the length of a reach is used as a weight. The total sinuosity of a river is calculated by using the following equation:

$$k_L = \frac{(L_1 * P_1 + L_2 * P_2 + \ldots + L_n * P_n)}{(L_1 + L_2 + \ldots + L_n)}, \text{ where}$$

k_L – weighted average value of the sinuosity factor;
L_1, L_2, L_n – sinuosity factors of individual reaches;
P_1, P_2, P_n– length of individual reaches.

The described calculation methods helps to compare the sinuosity of reaches within one river and the sinuosity of different rivers.

Hydromorphological pressures. Hydromorphological pressure shows the human impact on the hydromorphological status of a water body. Taking into account the natural conditions, specifics of watercourses and the impact of human activity on water bodies, the following pressures should be considered in the hydromorphological assessment of watercourses: straightening of the river channel, usually accompanied by dredging; water extraction and re-routing related to special use of water; impounding; changing the flow regime; bank structure. The impact of pressures is assessed for a river or a reach and also for a water body.

Modification of the river channel. There are two main types of human impact:

a) modification of the river channel (mainly dredging and straightening);
b) accumulation of sediments due to impoundment; this is a secondary impact and, therefore, it is not always practical to address this under the physical modification of the river channel.

In the morphological assessment of the channel, main attention is paid to the artificial channel and its percentage of the river or stretch concerned. The assessment is relatively complex because longer reaches flowing in artificial channels can be considered individual water bodies (artificial or heavily modified water bodies) and, therefore, the ratios vary. Also, the morphological status of the river channel can be assessed along the channel and by cross-sections. One of the disadvantages of the cross-section method is the great dependence on the level of water. Assessment along the river allows the use of parameter "slope", which can also be used to assess the differences in the flow regime, even along the whole river, if necessary. In Estonia, where the majority of watercourses are small, the use of the cross-section method is not justified.

It is obvious that the channel is natural if there is no artificial impact. However, even a straight channel may have become natural and should not be considered artificial if dredging and straightening occurred a long time ago. If the banks of such a reach are near-natural and with natural vegetation, the dredging and straightening done 50-60 years ago is not important any more. However, in such cases the final assessment must be based on the data gathered in the course of fieldwork. The morphological status of the river channel can be assessed by following criteria:

No effect – the share of artificial channel constitutes no more than 5% of total length;
Weak effect – the share of artificial channel is >5 to 15%;
Moderate effect – the share of artificial channel is >15 to 35%;
Strong effect – the share of artificial channel is >35 to 75%;
Very strong effect – the share of artificial channel in the reach concerned constitutes more than 75% of its total length.

The reaches in the category "very strong effect" should be considered heavily modified water bodies because they cannot be considered according to the typology of natural water bodies.

Water extraction and re-routing. This pressure factor describes the increase or decrease in runoff as a result of human activity. In the European context, the impact of reduced water level on fish fauna is considered strong when runoff decreases by more than 50% of the average median of the month. In Estonia, such amounts of water are only extracted from the surface water intake system in Tallinn and only in years when the water level is below average.

The impact of water extraction is assessed based on the number of days when the flow regime was altered as compared with the natural regime. Assessing this pressure factor requires daily measuring of runoff and, therefore, it can be used only for rivers that have operating hydropower plants. Also, the catchment area of the reach in question should not differ from the catchment area of the hydropower plant by more than 20%, presuming that there is no sharp change in runoff conditions between the two catchment areas, which is not related to the pressure factor under consideration.

Table 5. Assessment criteria for pressures caused by water extraction or re-routing.

Number of days if discharge Q differs from natural discharge	<20	20–<40	40–<60	60–<80	≥80
<5% reduction or <10% increase	1	1	1	2	2
5–<15% reduction or 10–<50% increase	1	2	2	3	3
5–<30% reduction or 50–<100% increase	1	2	3	3	4
30–<50% reduction or 100–<500% increase	1	2	3	4	5
≥50% reduction or ≥500% increase	2	3	4	5	5

Changing the flow regime. A change in the flow regime is a change in discharge caused by the temporal distribution of runoff and the resulting change in flow regime. Unlike water extraction or re-routing, the impact factor "Changing the flow regime" does not mean that the amount of water in the channel increases or decreases but that water is distributed over time. In Estonia, it is related to the use of hydropower if hydropeaking is used, which causes the flow regime in the river to change immediately below the hydropower station's threshold. In small rivers, discharge may suddenly change if a dam is opened, especially if this is done during high water or flood. The appropriate assessment criteria are following for Estonian rivers:

No effect – natural flow regime is maintained in the reach concerned or it is changed in up to 2% of days during a year (less than 7 days in a year);
Weak effect – flow regime is changed >2 to 5% of days during a year;
Moderate effect – flow regime is changed >5 to 20% of days during a year;
Strong effect – flow regime is changed >20 to 40% of days during a year.
Very strong effect – flow regime is changed >40 to 40% of days during a year.

In all cases, the speed of the increase or decrease in the level of water in the reach should not increase 5 cm per hour. Taking into account that the standard does not quantitatively determine the rate of change in flow regime, specifying conditions should be added in the Estonian context. A methodological and legal basis is the requirement to ensure ecological runoff which means that, when regulating runoff and changing flow regime, permanent ecological discharge Qecol or natural discharge if it is smaller than Qecol, must be ensured.

Impounding. Taking into account the effect of impounding to the migration of fish in the water bodies of various importance in terms of fish fauna, such an effect should be assessed separately by using the following division:

- water bodies that are spawning sites and habitats for salmonidae;
- remaining water bodies.

The physical condition of rivers has recently deteriorated due to dams built by beavers and the resulting clutter and vegetation. The optimal number of beavers has been exceeded and the beaver has become one of the main factors influencing the physical condition of small and medium-sized rivers (with a catchment area of up to 300 km^2). The number of beavers has increased partly because meadows by rivers have been abandoned and have overgrown with bushes and because hunters are not interested in hunting them. Beavers change the appearance of rivers significantly, turning smaller watercourses into "beaver rivers" and destroying the habitats of valuable fish species. In some locations, the activity of beavers may destroy the habitats of protected species. The excessive number of beavers also increases the loads from sediments and organic matter:

- the construction of beaver lodges and canals increases the erosion of banks and load from sediments;

- the flooding of low areas may result in an increase in the levels of nutrients and gases that can harm aquatic biota.

Therefore, beaver dams should be taken into account because a problem specific to Estonia is the high number of beavers and beaver dams on rivers and streams, which have an adverse effect on the hydromorphological status of watercourses (Table 6).

Table 6. Impact of impounding.

Impact grade	Habitat for salmonidae	Remaining water bodies
No effect	No dams.	No dams.
Weak effect	Dams are provided with fish passes.	Dams are provided with fish passes if this is required under the Water Act.
Moderate effect	Dams are provided with fish passes but these do not always function due to the scarcity of natural water.	Dams are provided with fish passes but these do not always function due to the scarcity of natural water.
Strong effect	Less than half the dams do not have fish passes or they are provided with fish passes but there are beaver dams upstream with the density of 1 dam per 2 km.	Dams do not have fish passes or they are provided with fish passes but there are beaver dams upstream with the density of 1 dam per 1 km.
Very strong effect	More than half the dams do not have fish passes or they are provided with fish passes but there are beaver dams upstream with the density of more than 1 dam per 1 km.	Dams are provided with fish passes but there are beaver dams upstream with the density of more than 1 dam per 1 km.

Bank structure. The analysed feature is the land use of banks and the ratio of natural and arable land. Water researchers believe that the status of watercourses, in particular the condition of aquatic biota is better if the vegetation on banks is natural, consisting mainly of trees. Besides forest community, meadows and bogs, mainly floodplain bogs, can be found on riverbanks. The aim is diverse and near-natural banks.

Assessing the structure of banks means that the share of natural and near-natural lands and cultivated land is determined. These are considered a buffer zone that protects the water body against diffuse pollution. The data on land use on both banks are taken into account. Based on Table A.1 of the standard *EVS-EN 15843:2010 Water quality – Guidance standard on determining the degree of modification of river hydromorphology*, it is recommended to use the following data:

Degree of impact	Share of natural and near-natural land, %
No effect	>95
Weak effect	85–95
Average effect	65–85
Moderate effect	25–65
Very strong effect	<25

Integrated assessment of hydromorphological pressures. Different methods can be used to prepare an integrated assessment of the hydromorphological status of watercourses and the impact of pressures. Standard *EVS-EN 15843:2010Water quality – Guidance standard on determining the degree of modification of river hydromorphology* describes the so-called simple method, according to which an integrated assessment is the mean arithmetic value of individual scores. The names of assessed units are given in Table 7.

Table 7. Integrated assessment of the hydromorphological status of watercourses according to the classification laid down in the standard *EVS-EN 15843:2010 Water quality – Guidance standard on determining the degree of modification of river hydromorphology*.

Score	Class	Description
1 to <1.5	1	Near-natural
1.5 to <2.5	2	Slightly modified
2.5 to <3.5	3	Moderately modified
3.5 to <4.5	4	Extensively modified
4.5	5	Severely modified

In overviews and assessments concerning the environmental status of water bodies, integrated assessment can be achieved with other methods, in particular where the assessed parameters do not have the same weight. Table 8 includes the classification of the hydromorphological status of watercourses, which takes into account the importance of different impacts. With regard to this classification, a question arises: if the values of all indicators belong to the first class, does that mean that there are no hydromorphological pressures, that is, the status of the water body is very good, or can a single indicator lower the status of the water body so that it has to be classified into a lower category. If all quality elements are assigned importance, then they cannot have the same weight, which is logical. If in assessing the structure of banks, it appears that the share of natural land is less than 85%, then the quality class is "poor" despite the very good morphological and hydrological status of the river.

In order to determine the importance of each factor, different factors are compared with each other and assessed on a scale from 0 to 1 with an interval of 0.2. The classification includes five hydromorphological features, each of which has a different weight and can have a value on a 5-point scale. Taking into account the importance factor, the scores may vary from 3.0 to 15.0. The classes of general assessment can be determined in the same way:

- Very good 3.0–5.0
- Good 5.1–7.5
- Poor 7.6–10.0
- Bad 10.1–12.5
- Very bad 12.5–15.0

Table 8. A scale for assessing the impacts on the hydromorphological status of watercourses by using a 5-band assessment system (the numerical value of each factor is given in brackets).

Feature	Importance	N/A (1)	Weak (2)	Moderate (3)	Strong (4)	Very strong (5)
Status of river channel	1.0	1.0	2.0	3.0	4.0	5.0
Water extraction and rerouting	0.8	0.8	1.6	2.4	3.2	4.0
Impounding	0.6	0.6	1.2	1.8	2.4	3.0
Changing the flow regime	0.4	0.4	0.8	1.2	1.6	2.0
Bank structure	0.2	0.2	0.4	0.6	0.8	1.0

Figure 3. Diverse banks of the middle reaches of the Pärlijõgi river between Saarlase and Kaugu (*left*) and a natural meadow and cops of trees on the bank of the Vaidva river downstream from Vastse-Roosa (*right*).

Figure 4. Limestone bank in the middle reaches of the fast-flowing Peetri river (*left*) and debris collecting behind a fallen tree on the Vaidva river (*right*).

7. Conclusion

In the Estonian context, the hydromorphological features that should be taken into account in assessing the ecological status of rivers are flow regime, sinuosity, variability of width and depth, and the nature of buffer zones on the banks. These elements should ensure natural diversity and the existence of numerous habitats in rivers.

Flow velocity is not a suitable feature because it varies greatly depending on the river discharge. Therefore, it is recommended to use a slope instead of flow velocity because the slope is easily determined, expressed also in a numerical value and reflects directly flow velocity. The slope and sinuosity can be used as suitable integral characteristics in the morphological assessment of rivers.

The morphological status of the river channel can be assessed both along the channel and by cross-sections. Taking into account that the assessment by cross-sections requires additional measurements, the more widely used method is to assess the status of the river channel along the channel, which allows using the longitudinal profile of the river as an important information source.

A problem specific to Estonia is the high number of beavers and beaver dams on rivers and streams, which have an adverse effect on the hydromorphological status of watercourses. Although not human-induced, the impact of this pressure factor on aquatic biota, including fish fauna, is obvious.

Assessing the structure of banks means that the share of natural and semi-natural land and cultivated land is determined. These are considered a buffer zone that protects the water body against diffuse pollution.

The classification includes five hydromorphological features, each of which has a different weight and can have a value on a 5-point scale. The integrated assessment of the hydromorphological status takes into account the importance of each feature, which helps to distinguish more relevant features from those that are less relevant and to make the result more objective.

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Hydromorphological reference conditions of streams based on the European Water Framework Directive

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This paper presents general approach for determination of type-specific reference conditions within the European Water Framework Directive in the cultural landscape of central Europe and determination of significant hydromorphological parameters for designation of reference sites. The reference conditions of streams should be determined for individual stream type to reflect undisturbed conditions of stream, which means natural sediment of river bed and banks, natural cross-section and channel planform, lateral movement of the stream in floodplain without limitations, natural sediment regime, migration of organisms and stream flow, bank vegetation corresponding with stream type and geographical localization. The reference conditions can represent a state in the present or in the past. They include very minor disturbances which means that human pressure is allowed as long as there are none or only very minor ecological effects. For the determination and the assessment of reference site the REFCON and HEM methods were applied. Using the agglomeration hierarchy clustering method, it was discovered that the average bed slope at a site, the Rosgen entrenchment ratio, and the w/d ratio are independent variables and can be used for establishing type-specific reference conditions. The above-described findings, just as the marked heterogeneity of each reference site, are essential for establishing the characteristics of other potential reference sites.

1. Introduction

The purpose of conducting hydromorphological and biological assessments of streams according to the European Water Framework Directive (2000/60/ES) is to assist in dealing with relevant aspects of water management. The purpose of hydromorphological evaluation is to determine if the status of hydromorphological conditions are sufficient for supporting biological elements. Status categories include: high, good, moderate, poor, and bad. From the perspective of water management, it is essential to understand variability in the behavior of riverine systems and their capacity for change. Classifying streams based on fluvial-morphological characteristics into groups with similar behavior enables streams to be assessed for instability and risks. The basic parameters that define stream morphology include: the width and depth of the stream channel during bankfull discharge, slope, bankfull discharge, stream channel sinuosity, flow velocity, the amount and size of sediment, erosion and accumulation, and stream channel roughness. If one is able to "categorize" streams based on their natural behavior, one will be able to predict changes related to their development, to establish strategies for the sustainable management of rivers, and fulfill the requirements of the Water Framework Directive 2000/60/ES (WFD) for the meaningful assessment of hydromorphological elements.

The European Committee for Standardization (CEN) has published two European standards outlining hydromorphological standards for rivers: EN 14614:2004 Water Guidance standard for assessing the hydromorphological features of rivers and EN 15843:2010 Water quality –

Guidance standard on determining the degree of modification of river hydromorphology. These standards must be taken into account. The WFD states that for each surface water category, the relevant surface water bodies within the river basin district shall be differentiated according to type and for each type of surface water body, type-specific hydromorphological conditions representing the values of hydromorphological quality elements at high ecological status shall be established as a critical base, enabling the classification of other statuses. Reference conditions should be determined for every river type so that they reflect undisturbed stream conditions, i.e., natural bed and bank materials including a natural cross-sectional profile and channel planform, movement of the channel through the floodplain without restriction, the natural movement of sediment and organisms, the natural flow of water, and natural bank vegetation corresponding to the river type and the geographical location of the river (EN 14614, 2004). Reference conditions may represent the current status of a stream or a past status and according to Guidance No. 10 (WFD CIS, 2003), reference conditions do not need to be the equivalent of absolutely undisturbed original conditions, as anthropogenic impacts that cause no or very little disturbance are allowed. The significance of defining reference conditions and establishing type-specific reference sites has been emphasized in studies presenting the findings of hydromorphological surveys conducted on streams (Matoušková, 2003; Matoušková (ed.), 2008; Matoušková *et al.*, 2010; Šmerousová 2010; Weiss *et al.*, 2008; Šípek *et al.*, 2010).

2. Methods

The basic steps for determining potential reference sites or values and establishing the boundary between high and good ecological status include: (1) identifying potential reference sites, (2) data collecting data for reference site validation, (3) using validated results to establish reference condition values, and (4) using the acquired information to establish the values defining the boundaries of each status class. Reference conditions should be established for the same indicators of quality elements that will be used for classifying ecological status.

Type-specific conditions may be spatially based (using data from monitoring sites), based on predictive modeling or hindcasting methods using historical, paleological, or other data, or derived from a combination of these methods. In cases where these methods cannot be applied, expert judgment may be used to establish such conditions (WFD, Guidance 10). Table 1 summarizes the strengths and weaknesses of the methods used for establishing reference conditions in select EU Member States. In the Czech Republic, biological and general physicochemical indicator reference conditions were derived using a method for establishing reference sites based on data from existing monitoring. Hydromorphological data that systematically covers the entire Czech Republic are not yet available.

Table 1. Methods for establishing reference conditions in select EU Member states, strengths (+) and weaknesses (-)

Method for establishing reference conditions	Strenghts +	Weaknesses -	Select EU Member States[1]
Spatially based methods using survey data	Temporal and spatial variability can be taken into account; in terms of data accessibility, it is a simple method	Undisturbed or minimally disturbed sites must be available; large data sets must also be available for all types - cost intensive	Austria, Germany, Slovakia, Slovenia, Spain
Predictive modeling	Data from similar regions or types can be borrowed; a lower number of sites/samples is necessary to establish conditions - lower costs	Requires data, calibration, and validation; valid only for the site/type it has been created for	Italy the United Kingdom – established as conditions without any anthropogenic modifications
Historical data, paleo-reconstruction	Can be used in areas with anthropogenic impact where reference sites cannot be located; often inexpensive	Variable data, few indicators, data quality may be low or unknown, data may be missing.	Belgium
Expert judgment	Can be combined with other methods, can be used when reference sites cannot be located	Substantial subjectivity (particularly when this method is the only source), usually qualitative in nature, lack of quantitative measurements for validation, often static values	

[1] Supporting documentation for the CIS workshop (2012)

2.1. Establishing reference conditions in neighboring EU Member States

In Austria, hydrological reference statuses are based on stream typology, i.e., by categorizing streams according to bioregion, catchment size class (1–4), and altitude class (1–5). The determining parameters for determining hydromorphological reference status include: runoff regime type, flow character, stream order, valley type, slope, planform, width and depth variability, hydromorphological features, and bed characteristics. Reference reaches were delimited by mapping the ecomorphological structures throughout all of Austria, where only reaches achieving a quality score of I or II were used for defining reference conditions. In total, the University of Graz statistically evaluated 6,500 reaches (Wimmer *et al.*, 2012).

The German method for defining reference status is based on the geomorphological characteristics of streams. Reference sites were evaluated based on statistical analyses of similarities in sites that have very little anthropogenic impact. From the perspective of hydromorphology, the following parameters are taken into account: planform and sinuosity, valley type, bed substrate, and characteristics of stream cross-sectional profile and the floodplain. A big plus for defining reference conditions in Germany is that ecomorphological surveys of streams using both the applied LAWA-OS and LAWA-FS methods are derived from its natural status, whose qualitative characteristics are identical with the reference conditions and point evaluation is specified for basic stream types (Kern and Sommer, 2000). Mapping river habitat structures results in the clear identification of natural reaches, or reaches with very little anthropogenic impact. Hydromorphological reference statuses have been prepared and defined in detail for each state (*Bundesland*).

In Slovakia, a method for assessing hydromorphological elements has been developed (Lehotský and Grešková, 2004), which is based on the German method for large rivers (Kern and Sommer, 2000) and has been modified for use in Slovakia. Hydromorphological reference condition definitions were derived from a hydromorphological survey conducted by the Slovak Hydrometeorological Institute (SHMI) in 2004–2005. Reaches were selected as reference sites that indicated high hydromorphological status. Parameters defining reference conditions were grouped into three categories: hydrological regime, migration permeability for water organisms, and hydromorphological conditions. The results of the preceding hydromorphological survey (Lehotský and Grešková, 2004, Lehotský, 2006) were used for the hydromorphological parameters.

2.2. A proposal for the REFCON method for establishing reference conditions and selecting references sites in the Czech Republic

To define surface water types for establishing reference conditions, the approved type classification of flowing waters (Langhammer *et al.*, 2009) must be used, although it is possible to modify it when there is a lack of data for a certain type (Opatřilová *et al.*, 2013).

Considering the fact that a systematic hydromorphological survey has not yet been conducted in the Czech Republic that could provide relevant data for establishing reference conditions with the help of reference sites, or using spatially based data acquired from a survey, basic hydromorphological characteristics should be systematically determined using distance data for streams in the Czech Republic to provide a base for putting streams into groups based on similarities in behavior (valley bed slope, stream order, sinuosity, etc.) Furthermore, distance data should be used to determine the basic characteristics of catchment basins (altitude, slope, aspect, bank susceptibility to erosion, hydrological regime and anthropogenic impact, land cover, and soil characteristics of the flood plain). Selecting reference sites should be based on assessing distance data and the selection of suitable sites by experts from the river basin authority. Subsequently, a detailed field survey will need to be conducted to validate the selection of potential reference sites as well as hydromorphological stream characteristics used to identify reference conditions.

In order for a reference site (RS) to be selected, the following criteria within the REFCON method (Matoušková and Šmerousová, 2014) need to be met:

(1) unimpacted hydrological regime (no crosswise obstacles above 0.5 m at the RS, no dams, reservoirs, or pond systems consisting of two or more ponds above the RS, no significant water extraction or diversion at the RS),
(2) natural banks, bed, and channel course at the RS with a natural channel for at least 1 km above the RS,
(3) flood plain with a good status at the RS (forest, permanent grassland, wetland), and
(4) no significant sources of municipal, industrial, or agricultural pollution above the RS.

In the Czech Republic, this method for establishing reference conditions from reference sites can only be used on the upper and middle courses of rivers where suitable reference sites can be found; however for the lower courses of significant rivers, where the landscape has been subject to intensive anthropogenic activities for centuries, this method cannot be fully applied and it would therefore be better to establish the best existing conditions, in combination with using historical data and expert judgment.

Establishing reference conditions must be done in accordance with current stream typology in the Czech Republic, which means that from the beginning of this process altitude and Stahler stream order in particular should be taken into account as the most important hydromorphological parameters of stream types in the Czech Republic. Considering that many headwater areas in the Czech Republic (the Šumava and Krušné hory Mountains) feature level ground, valley bed slope in addition to altitude should be used to define reference conditions. Other determining factors include: runoff regime characteristics (including channel capacity), flow character especially in relation to the sediment regime, groundwater connectivity, and interaction between the channel and the floodplain. Migration permeability and indicators of the anthropogenic impacts of bank vegetation, stream channel shading, and the character of shore vegetation also appear to be important parameters.

Reference sites should consist of reaches at least 1 km long, along which the following detailed characteristics should be recorded: (1) longitudinal profiles along the entire length of the RS, (2) sediment character assessment (Wolman, 1954), (3) measurement of at least 5 cross-sectional profiles including a detailed assessment at 50 m both upstream and downstream (for river channels wider than 30 m, 100 m upstream and downstream), (4) assessment of bed structure, presence of micro- and meso-habitats, and (5) assessment of the area surrounding the stream and vegetation. Finally, the hydromorphological status of the RS should be validated by a control assessment using the HEM method (Langhammer, 2009, 2010). Basic characteristics of RS assessment are summarized in Table 2.

The REFCON method was tested in the autumn of 2013 in select model catchment basins; in addition to the establishment of hydromorphological characteristics important for determining type-specific hydromorphological reference conditions at reference sites in select model catchment basins, hydromorphological surveying was conducted using the HEM - Hydroecological monitoring method (Langhammer, 2009). The Rolava, Bystřička, and Černá Ostravice river basins were selected to serve as model catchment basins.

Table 2. Characteristics assessed at reference sites using the REFCON method.

Stream channel	Cross-sectional profile (detailed measurement by orthogonal survey)	Average channel width w at Qkk (m)
		Maximum depth (m)
		Average maximum depth at the site d (m)
		w/d
	(detailed orthogonal survey of cross-sectional profiles and establishing these characteristics for each cross-sectional profile and for reaches 50 m above and below stream of the cross profile)	Valley type
		Bed structure in % (bars, islands, riffles, pools, rapids, rock steps)
		The width of the floodplain at double the maximum channel depth (m)
		Susceptibility of banks to erosion (bank vegetation, substrate, bank scour, bank slides, amount of sediment for potential transport)
		The stability of the cross-sectional profile in the reach
		Presence of significant pools
	Longitudinal profile	Average bed slope at site

		Measurement of the longitudinal profile along the centerline
		Stream power (W.m^2)
	Channel course	Planform
		Sinuosity (length of the channel along the centerline/length of the valley) - from distance data
	Sediment character	Application of the pebble count method (Wolman, 1954)
	Presence of micro- and meso-habitats	Depth variability in the cross profile
		Bank roughness (hiding spaces for animals)
		Vegetation in the channel
		Accumulation of detritus
	Hydrological regime	Flow character (waterfall, steps cascade, rapids, runs, glides, pools, impoundment)
	(determined with distance data)	Month with highest runoff
		Runoff fluctuation as a ratio of average monthly runoff rates of the months with the most and least runoff
		Qa (m3.s-1) in the period 1981–2010
Stream surroundings	Retention potential of the floodplain (not assessed in gorges, canyons and V-shaped valleys)	
	Width of the flood plain (not assessed in gorges, canyons, and V-shaped valleys) - left and right bank, minimum and maximum	
	Impact of artificial structures (longitudinal and crosswise) on flow in floodplain	
	Character of vegetation	Bank vegetation (channel and 1 m beyond the bank edge, emphasis on trees)
		Channel shading
		Existence of natural vegetation in the shore zone (depending upon the width of the channel: for streams up to 10 m in width at least 10 m, for streams above 10 m in width at least 20 m, for streams above 30 m in width at least 50 m)
		Character of vegetation in the shore zone

3. Characteristics of the model areas

Model catchment basins were selected that met the criteria for selecting reference sites and also so that they cover the various physical geography conditions present in the Czech Republic.

The river basin of the Rolava River is located in the Krušné hory Mountains in the northwest of the Czech Republic (Fig. 1). Its northern part lies in Germany (50°24’05’’N, 12°36’55’’42 E, 920 m a.s.l.). In the south it discharges into the Ohře River at Karlovy Vary (50°14’10’’N, 12°52’15’’E, 370 m a.s.l.). The Rolava starts on the Krušné hory Plateau. The source is located in the Czech-German border region. Its lithology is dominated by granite, gneiss, and mica schist. The whole river basin covers an area of 138 km^2. The length of the main stream is 36.6 km. The mean daily discharge is 2.39 m^3 sec^{-1}. The water basin is characterized by variable runoff with relatively frequent flooding. The largest runoff typically occurs in April and March, due to snowmelt. The catchment is subdivided into three water bodies. The upper stream runs through the flat, forest-free terrain of the Přebuz Nature Reserve, which features large peat bogs important for water retention. The middle course of the Rolava changes into a wilder mountain forest stream with a riverbed of stones and even boulders and steep slopes. The studied reference reach is located in this section. The length of the reference reach is 993 m; its starting point is at 50°17.117; 12°46.144 and its end point at 50°17.338, 12°45.548. Thereafter, the stream runs through built-up areas in the village of Nové Hamry and the town of Nejdek. The slope ratio slowly decreases downstream, where the Rolava passes through Nová Role and the city of Karlovy Vary. Due to the frequent occurrence of flood discharge, flood protection measures have been taken. River channel alterations are also associated with the construction of small water power stations and roads (Weiss *et al.*, 2008, Matoušková *et al.*, 2010).

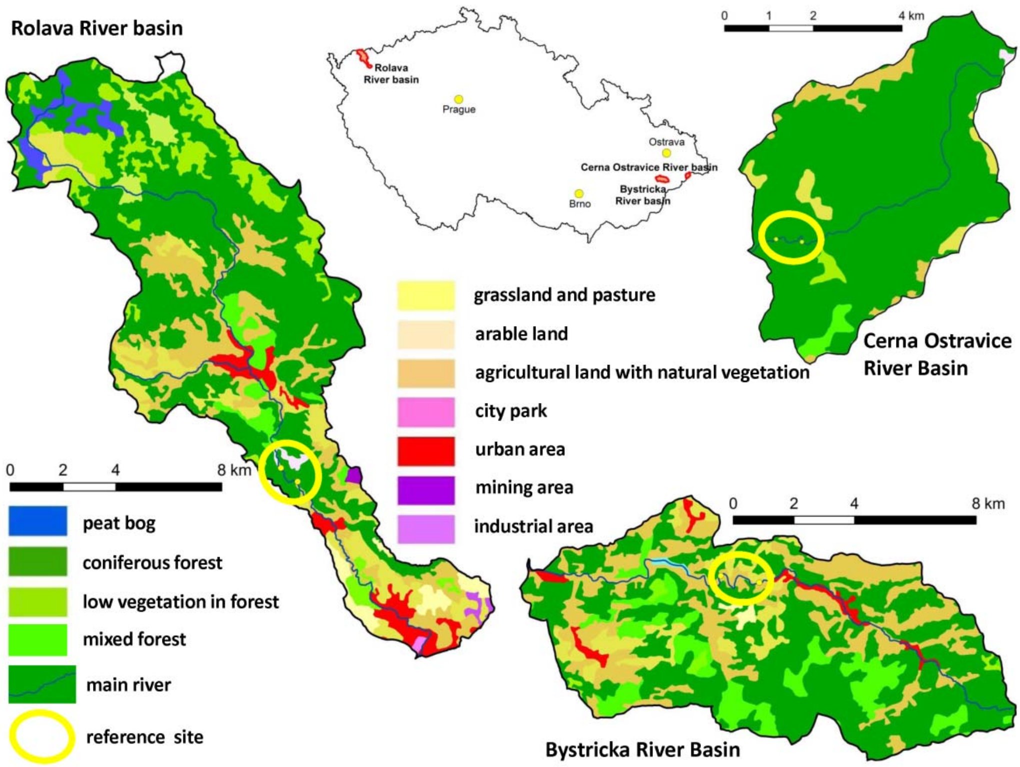

Figure 1. Land Cover in case study river basins (Source: Corine Land Cover, 2006).

The Bystřička River basin is located in the Beskydy Mountains in the east of the Czech Republic (Fig. 1). The headwaters of the Bystřička are located at an altitude of 868 m a.s.l. (49°38’52’’N, 18°18’52’’E), and it discharges into the Vsetínská Bečva at an altitude of 302 m a.s.l. (49°42’00’’N, 17°96’25’’E). The whole river basin covers an area of 86 km^2. The length of the main stream is 22.2 km. The mean daily discharge is 0.90 m^3 sec^{-1}. The largest runoff typically occurs in March, due to snowmelt. The catchment consists of only one body of water. The Bystřička catchment basin is largely covered in forests and meadows with natural vegetation; nonetheless it is a mountainous basin with a narrow valley along the Bystřička and includes the villages of Valašská Bystřice and Bystřička (Fig. 1). These dispersed built-up areas have a negative impact on the ecological status of the stream. The Bystřička Reservoir covers an area of 0.38 km^2 and has a maximum depth of 26 m; it is located on the lower course of the stream. The reference site is located on the middle Bystřička, approximately 1.5 km from the start of impoundment. The length of the reference reach is 738 m. Its starting point is 49°25.187'; 18°3.042', and its end point is 49°25.218', 18°3.718'.

Tha Černá Ostravice River basin is located in the Beskydy Mountains in the east of the Czech Republic (Fig. 1). The headwaters of the Ostravice River are located at an altitude of 850 m a.s.l. (49°49'28''N, 18°54'09''E) on the state border with the Slovak Republic, and at the confluence with the Bílá Ostravice River at an elevation of 529 m a.s.l. (49°45'30''N, 18°46'46''E) it becomes the Ostravice River. The whole river basin covers an area of 29 km^2. The length of the main stream is 9.4 km. The mean daily discharge below the confluence with the Bilá Ostravice River is 1.50 m^3 sec^{-1}. The largest runoff typically occurs in March, due to snowmelt. The catchment consists of only one body of water. The catchment basin of the Černá Ostravice is practically completely forested and fully unsettled. The only anthropogenic impact on this catchment is an impoundment with a capacity of 6,300 m^3 and that is approximately 40 x 60 m and built on the upper course to optimize runoff and sediment regimens. It has a certain, but acceptable, impact on the hydrological regime at the reference site, which is located at the lower course of the stream above the confluence with the Bílá Ostravice. The length of the reference reach is 564 m. It starts at 49°27.460'; 18°28.575' and ends at 49°27.459', 18°29.055'.

4. REFCON test results in the select experimental catchment basins

Based on the REFCON methodology, a set of characteristics was collected by a field survey of the reference sites. The set was established directly for 18 cross-sectional profiles or determined from profile localization within the reference sites. Then the relationships between these characteristics were assessed.

To validate the links between the characteristics, the agglomerative hierarchical clustering (AHC) method was used, which evaluates the distance between objects. The Pearson correlation co-efficient was used for determining distance criteria, and the simple linkage clustering method was used as an agglomerative method. The goal was to test the suitability of the selection of the hydromorphological characteristics for determining type-specific hydromorphological reference conditions, correlations between characteristics, and if they are mutually interchangeable. The results from analysis demonstrating correlations between characteristics can be found in Fig. 2. The amount of rapids in the stream bed structure demonstrates a strong correlation with average bed slope. The presence of riffles demonstrates a correlation with the Rosgen entrenchment ratio (width of flood plain in double of maximum channel depth divided by channel width). Both of these characteristics demonstrate a weak correlation with the presence of pools. Average channel width at Qkk and the width to depth ratio appear to be interchangeable especially since the maximum depth of cross-sectional profiles do not significantly differ. Both of these characteristics however demonstrate a correlation with the presence of bars and islands in the stream channel.

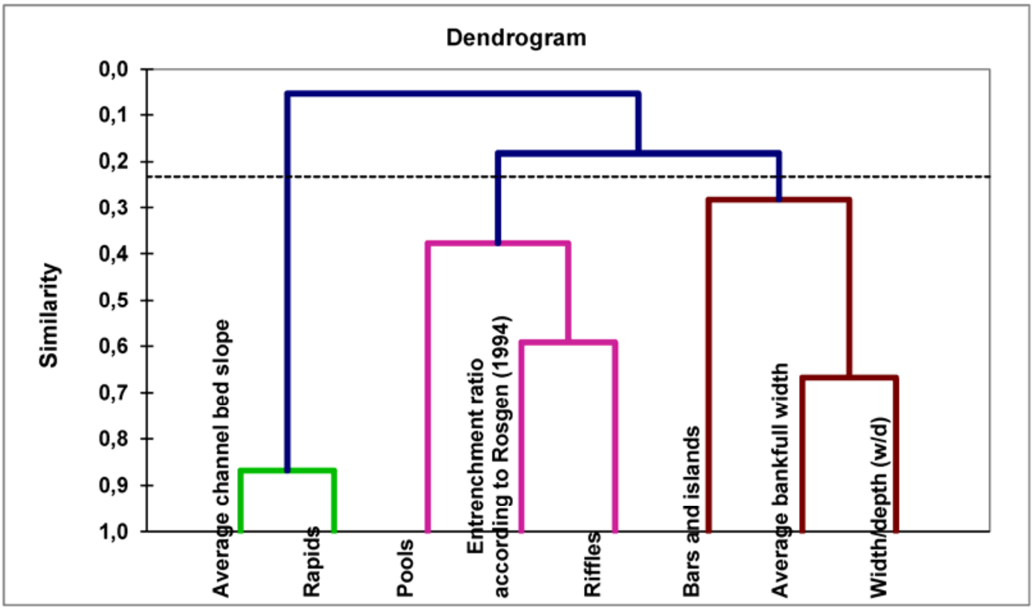

Figure 2. Interaction between selected characteristics obtained by field survey display by Agglomerative Hierarchical Clustering (AHC) classification method.

Therefore, the average bed slope of the site, the Rosgen entrenchment ratio, and the w/d ratio can be considered to be independent variables and can be used to establish type-specific reference conditions.

Dependences between individual characteristics were determined by using linear regression. The amount of bars and rapids in cross-sectional profiles demonstrate a marked correlation with bed slope at reference sites. The greater the bed slope, the less the accumulation in the form of bars and islands. When the slope is greater, the number of rapids grows. The presence of bars in bed structure is positively dependent on channel width. A high Rosgen entrenchment ratio value indicates a well-developed floodplain. Based on the conducted analysis, the Rosgen entrenchment ratio indicates a weak negative dependence on the w/d ratio. Thus, the wider and shallower the channel, the greater stream entrenchment in the valley is. It is however generally assumed that the wider and shallower the channel, the more developed the floodplain of the stream is. This very weak dependence can be explained by the fact that relatively wide channels at reference sites are very markedly entrenched in the valley.

Reference sites are located in mountainous and sub-mountainous areas of the Czech Republic but within catchment basins they were always selected from the middle or lower courses of the stream. The average bed slope at the reference sites on the Černá Ostravice and the Bystřička approach a value of 1 %, whereas in the headwater areas of both of these streams springing from the flysch peaks of the Beskydy Mountains these values are higher. The headwater area of the Rolava River is located on quite level ground. The Rolava then drops significantly through the Krušné hory Mountains and thus the reference site on the lower course of the Rolava indicates a gradient of 1.2 %. Rapids dominate the bed structure at all reference sites (on the Rolava River they make up 80 % of all bed structures). On the Bystřička there are also riffles flowing over exposed bedrock. Considering the amount of transported sediment in the Černá Ostravice, bars have a significant presence here. The longitudinal profiles of all three reference sites demonstrate marked variability; riffles, pools, and sediment accumulation alternate (Table 3).

Table 3. Basic characteristics of reference sites.

Reference site (river)	**The Cerna Ostravice River**	**The Bystricka River**	**The Rolava River**
Stream channel			
Cross-sectional profile			
Average channel width w at Qkk (m)	**12,07**	**12,78**	**11,70**
Maximum depth d (m)	**1,12**	**1,48**	**1,18**
Average maximum depth at the site (m)	**0,71**	**1,28**	**0,90**
w/d	**10,78**	**8,64**	**9,92**
Valley type	U-shaped to asymmetrical	U-shaped	U-shaped to asymmetrical
Qa (m^3.s-1) in the period 1981-2010 (ČHMÚ)	1,500 (below confluence with the Black Ostravice River)	0,899	2,450
Longitudinal profile			
Average bed slope at site	**0,98 %**	**1,04 %**	***1,20 %***
Channel course	meandering to braided	Meandering with long straight reaches	straight
River bed structure (%)			
Bars	**35**	20	
Islands	5		
Riffles	15	**40**	5
Pools	15	5	5
Rapids	**30**	**35**	**80**
Rock step, cascade			10
Presence of micro- and meso-habitats			
Depth variability in the cross profile	high	high	high
Bank roughness (hiding spaces for animals)	high	high	high
Vegetation in the channel	soft, hard	soft	soft
Accumulation of detritus	no	yes	yes
Stream surroundings			
Retention potential of the floodplain (not assessed in gorges, canyons and V-shaped valleys)	natural dimensioning of the channel, possibility of overflow		
	existing potential of floodplain – forest	existing potential of floodplain – grassland, locally high natural banks not allowing overflow	existing potential of floodplain – forest
Width of the flood plain (not assessed in gorges, canyons, and V-shaped valleys) – left and right bank, minimum and maximum	left bank (0/50), right bank (0/80)	left bank (10/30), right bank (50/100)	left bank (5/12), right bank (0/0)

Reference site (river)	**The Cerna Ostravice River**	**The Bystricka River**	**The Rolava River**
Impact of artificial structures (longitudinal and crosswise) on flow in floodplain	no	no	no
Character of vegetation			
Bank vegetation (emphasis on trees)	forest	gallery forest	forest
Channel shading	yes, partially	yes, significantly	yes, significantly
Existence of natural vegetation in the shore zone	yes	yes	yes
Character of vegetation in the shore zone	managed forest	pasture	natural forest

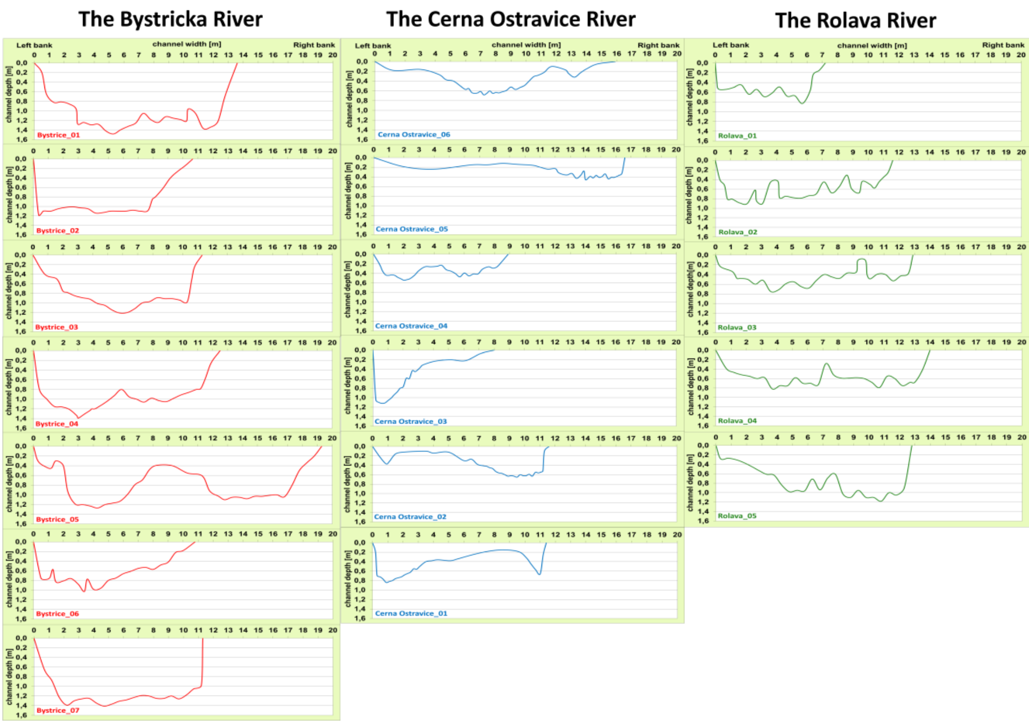

Figure 3. Variability of individual cross-section profiles in reference sites in flow direction.

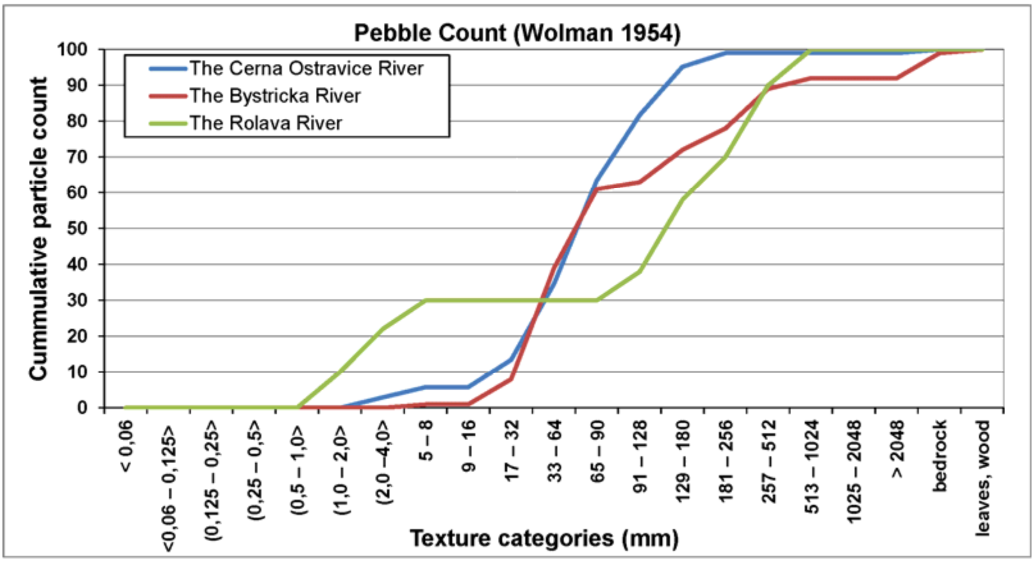

Figure 4. Outputs of Pebble Count method (Wolman, 1954) in reference sites.

At the reference sites, a total of 18 cross-sectional profiles were selected and surveyed; these profiles are depicted in the same scale in Fig. 3 downstream. The Bystřička River was found to have a deep channel with the greatest capacity, which in places reached the bedrock, while other places indicated a presence of gravel accumulation and islands. In comparison with the other reference sites, the Černá Ostravice has a shallow channel with an enormous amount of transported material, which is reflected in alternating significant accumulation on the right and left banks, including islands. For the Černá Ostravice, considerable variability along the longitudinal profile is typical. In contrast, cross-sectional profiles from along the entire longitudinal profile of the Rolava along the entire stretch were typically heavily rough, featuring boulders and rapids in the stream bed. The above-described facts are supplemented by the determined ratio of the average channel width to the average maximum depth w/d (Table 3).

Fig. 4 expresses the cumulative number of particles per recorded size category using the pebble count method (Wolman, 1954). At least 100 particles were selected using the zigzag principle. Whereas sediment ranging in size from very coarse gravel to small to medium cobble is typical for the Černá Ostravice, extensive accumulation of very coarse gravel and small cobble in the channel dominated the Bystřička, followed by small boulders (257–512 mm). In the Rolava River, categories ranging from large cobble to medium boulder were most frequent and supplemented by finer sediment below obstacles (size category very coarse sand to fine gravel).

At all reference sites, there is retention potential for high waters to exceed the banks without affecting flow in the floodplain with artificial longitudinal or crosswise structures. All reference sites indicated significant valley asymmetry. Whereas the Bystřička valley can be described as U-shaped with a well-developed floodplain, the Rolava is in places so entrenched in rock walls that is has no floodplain on the right bank. Bank vegetation consists of full-grown trees that shade the water surface; shore vegetation consists of forests or permanent grassland (Table 3).

5. Discussion and conclusions

Reference conditions for hydromorphological elements should be established in accordance with the WFD and the Czech stream typology (Langhammer *et al.*, 2010) and should at the same time reflect the variability of streams in the Czech Republic, covering streams of various size, differences in conditions in upper and lower steam courses, as well as the diversity of physical-geographical conditions in the country. Classification always involves simplifying reality into quantifiable characteristics or quality levels (Rosgen, 1994). For establishing hydromorphological reference conditions, this simplification should support the interdisciplinary utilization of the outcomes for biological elements, specify ecological status assessments according to the WFD, and give clear answers to questions of stream management. The method for establishing hydromorphological reference conditions in the Czech Republic was selected taking into account the (in)accessibility of historical data and how well this data has been processed, and the demands on creating a functional model at the state-level and at the same taking into account experience gained in other EU Member States which derived their reference conditions for hydromorphological and biological elements from long-term field monitoring and measurements taken using the "reference site" method. Establishing reference conditions on a macroscale is based on the generalization of basic fluvial morphological and general physical geographical characteristics of the Czech Republic and the suitable selection of reference sites should enable the validation of data and the specification of results at the microscale. In water management practice it appears as if using distance data sources in collaboration with information and data sources from river basin authorities is optimal. However, verification and a study of reference sites based on a field survey are necessary. Králová (2013) verified the applicability of distance methods for medium and large rivers. Both methods, whether solely field methods or solely distance methods, have certain built-in limitations, e.g., insufficient spatial resolution of image data, generalization of thematic maps, inaccessible terrain, poor visibility of meso- and micro-habitats due to turbidity, or the height of the water column. Therefore, it seems that for selecting reference sites, a combination of both methods should be used.

Current findings from field research indicate that defined criteria for selecting reference reaches are strict but realizable. Using the agglomeration hierarchy clustering method, it was discovered that the average bed slope at a site, the Rosgen entrenchment ratio, and the w/d ratio are independent variables and can be used for establishing type-specific reference conditions. Examining the correlations between each characteristic demonstrated a correlation between the number of bars and rapids and the bed slope at reference sites. In contrast, a correlation between the Rosgen entrenchment ratio and the w/d ratio was not demonstrated. The above-described findings, just as the marked heterogeneity of each reference site, are essential for establishing the characteristics of other potential reference sites that will be subjected to similar analyses and subsequently will serve for establishing type-specific reference conditions.

The results of current research demonstrate that it truly is meaningful to compare the same or related types of streams. Comprehensive assessments are very important for conducting surveys of reference sites, especially from the perspective of space, i.e., the highest functional unit is the catchment basin, followed by the floodplain, the shore zone, and the stream channel. At the same time, for reference sites it is necessary to assess longer homogeneous reaches while taking into account the status of lower and upper reaches as well as the principle of stream continuity. Lehotský and Grešková (2008) emphasize the significance of the channel-floodplain functional unit. The dynamics of fluvial-morphological processes (erosion and accumulation) play a very critical role at reference sites. It is important to recognize whether these phenomena are natural or anthropogenic. In practice, a combination of both factors may be the cause. From the perspective of assessing the ecological status of streams in accordance with the WFD, determining risk factors and their impacts on the physical habitats of streams is critical.

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The changing relations among resources, communities and institutions in Sardinian wetlands

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During the past few decades, coastal wetlands in the Mediterranean region experienced phases of generalized and intense destruction followed by increasingly effective and widespread conservation policies. The case of Sardinia, analyzed through the complex relations among fishing activities and environmental protection within changing institutional frameworks in Tortolì and Cabras, shows interesting examples of growing awareness of the value of ecosystemic services. The overlapping of projects related to recreation and tourism and the revitalization of fishing traditions and productions, along with widespread critical issues still related to the expansion of human activities in fragile coastal environments and to a persistently marginal socio-economic context, creates crucial challenges for local development. The analysis of these systems shows their changing character, through complex forms of relations among wetland environments and human societies, and highlights the potential and risks of locally managed planning.

1. Introduction

Within a relatively short period of time, Mediterranean coastal wetlands experienced phases of generalized and intense destruction (particularly through land reclamation) followed by widespread protection (particularly following the Ramsar Convention), thus paradigmatically showing how processes of "value assignment" can realize a dynamic process of "location production" (Lefeuvre *et al.*, 2002; Scampini and Ciampi, 2010; Turner *et al.*, 2000; UNDP, 2009). This process occurs through different practices and policies according to changing power relations behind the processes of construction of spatial artifacts and the local unique relations among environment, land and social development (Pearce, 1996; Thibodeau and Ostro, 2001). Over the past decades, many institutional initiatives have focused on coastal wetlands, within a framework in which the rhetoric of the action emphasized the opportunities for resource protection, improvement of production, exaltation of local knowledge, take-off of a new entrepreneurial spirit (Scodari, 1994; Schuyt and Brander, 2004). The image that is conveyed by many of these interventions is that of rural areas and subregions which should be able to derive their specificity from landscape, folk traditions, handicrafts and food products. These elements, which are important for tourism and for global economy, take on new symbolic meanings in this context (Lai and Sistu, 2012).

The valuation of ecosystems is therefore associated with specific social and anthropological characters, as well as power relations among specific stakeholders (Bardecki, 1998). In this

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sense, different processes which are redefining power relations in the wetlands of Sardinia will be analyzed, focusing on two cases (Tortolì and Cabras) where the reshaping of interests related to integral protection, fishery and tourism produces a complex mosaic of relationships within a fragile system of power in its formal and informal dimensions.

2. Between land and water

The adopted theoretical framework recalls Foucault (1977), as well as Raffestin (1980). The idea is that any relation between social subjects implies unbalanced relations of power and thus displays political strategies in any territorial framework of human action (Painter and Jeffrey, 2011; Rossi and Vanolo, 2010; Governa and Memoli, 2011).

This is particularly evident in institutional and formal relations but also in those that involve informal groups, able to trigger social changes through less conventional instruments. These actions tend to identify the territorial space as an arena as well as a product of the conflict itself. Wetlands, in particular, tend to suffer from an apparent clash of interests between exploitation and ecosystem protection; but, as Mathevet points out (2004, 17), understanding their values and their functions is of capital importance if a society wants to preserve and manage them in sustainable ways. This would imply taking account of the peculiar challenges and difficulties related to conservation and management, as well as the specific value that wetlands have in biodiversity protection, water resources management and flood prevention.

The claim that they constitute a "space-problem" in territorial planning is also the result of contradictory strategies developed through the centuries around their conservation and/or reduction. These contradictions are reflected in planning practices and in the evolution of legislation and related regulations.

2.1. Management

Wetlands have often been victims of their bad reputation over the last few centuries. In particular, in the Mediterranean region, they used to be generally perceived as unhealthy and dangerous places. In the collective view, the relation between marshes and malaria has played a major role in the formation of the strongly negative repute which characterized these environments until recent times (Tognotti, 2008; Soru, 2000).

As of the end of the 19th Century, technological knowledge was applied to their transformation and to the control of water levels according the local social convenience. At the same time, hygienist theories blamed stagnant waters for air insalubrity and many endemic or epidemic diseases. This approach motivated and encouraged numerous engineering actions of deviation or canalization of rivers and streams to the detriment of coastal wetlands, in order to favour agricultural expansion, urbanization and construction of roads, railways, ports and airports. This process intensified in the second half of the last century due to post-war reconstruction and further expansion of intensive agriculture, before the rapid advent of coastal tourism (Van Vuuren and Roy, 1993). Their protection was long considered of little or no economic value compared to other uses that could have generated more immediate and visible opportunities. Strategic choices underestimated the general and economic value of wetlands, associating them with excessive short-term costs of protection rather than long-term opportunities (Barbier *et al.*, 1997; Beecher, 1994; Earll, 2005; Environment Canada, 2001). Inadequate understanding of temporality and ecosystemic services led to numerous improper choices. Thus, since 1900, more than half of the world's wetlands have disappeared (Barbier, 1993).

Wetlands are an arena where different, often conflicting interests overlap. Moreover, for the most part, these territorial systems are public goods, without clear property rights and with frequent weaknesses in the protection of the collective interests (Ostrom, 1990). In order to orientate planning choices towards a more effective protection, their values and opportunities, including economic ones, should be properly estimated.

Economic literature proposes several methods to estimate the economic value of wetlands, in terms of use values and existence values. Many of the benefits of direct use are linked to tourist activities (Andereck, 1993; Bacon, 1987; Eagles *et al.*, 2002). In this case, the process of territorial construction is influenced by political entities (European Union, national and local governments) and economic actors (companies, professional associations, individual operators), as well as experts from universities and research centers (Papa, 1999; Piermattei, 2007). These mechanisms are able to generate and convey a specific exogenous image of a location (Siniscalchi, 2000). Thus, agricultural and crafts productions can become true "cultural objects", recognized as expressions of territorial systems' abilities (Lai, 2007; Sistu and Lai, 2012).

3. Values

Lagoon areas and other wetlands are in a state of constant change, which is closely linked to the perception that human societies have about them. Most of the change processes are subtle, but they all produce some sort of immunization defense against their own disappearance, even if human intervention often causes accelerated aging and decay of these basins.

The concept of wetland was defined in the Ramsar Conference in 1971, whose final document's definition includes "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres", and also "riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands".

This definition encompasses a complex series of ecosystems, either natural or transformed by human actions, for the most part present in the Mediterranean and its islands. These are areas of great importance from geological, chemical, physical, biological, ecological and economic points of view. The articulation of aquatic vegetation is accompanied by a fauna represented by invertebrates, amphibians, reptiles, mammals and many species of fish (Della Pietà, 1999). However, birds largely represent the iconography of wetlands, in terms of attractiveness (as birdwatching has become a metonym for all activities of production, education, leisure and culture) and conflicts (for example, competition among cormorants and fishermen).

If we limit the analysis to coastal wetlands, Sardinia has an extensive system of ponds and lagoons located along its perimeter like a crown. It is one of the largest wetland systems in the Mediterranean (Cannas *et al.*, 1998; Tiana and Schenk, 1998). The Italian Government ratified the Ramsar Convention in 1976 and included in the list 46 areas, 8 of which are located in Sardinia (with a total surface of 12,570 hectares). All of them are located along the Southern and Western coasts of the island (provinces of Cagliari and Oristano). The protection of wetlands was further strengthened thanks to the opportunities arising from the Directive 79/409/EEC "Birds" (partially implemented by Italy through the Law 157/1992) on the protection of wild birds, especially those in risk of extinction. Accepting this Directive, Member States shall undertake specific protection for territories hosting the species listed in Annex I, classifying them as Special Protection Areas (SPAs). Other wetlands of various types and sizes, scattered along the coasts of Sardinia, fall within several types of protected areas, including National Parks (La Maddalena and Asinara), Protected Marine Areas, Regional Natural Parks

(LR 31/1989), Regional Reserves (Wildlife Protection Oases) and Sites of Community Importance (SCI) under the Directive 92/43 EEC ("Habitat").

From a morphogenetic point of view, the coastal wetlands of Sardinia can be divided into different categories: some of them are true ponds located at the mouths of rivers following their obstruction and extension into retrodunal water bodies and channels. Another type of wetland can be found along the coastal fronts of plains affected by subsidence processes where submersion gulfs (Cagliari, Oristano, Palmas, Asinara) were barred by long regular beaches (such as the Plaia of Cagliari) with the formation of lagoons which progressively turned into the largest ponds of the island, such as those located at the two tips of the Campidano plain. Finally, a third type, largely created by marine action, includes coastal lagoons formed by the obstruction of ancient inlets through the formation of sand spits which leaned on headlands, such as San Teodoro and Calich, or minor islands facing the coast, as in Capo Bellavista and Capo Mannu (Mori, 1975, 95–96).

4. Conflicts

The coastal location of Sardinian wetlands exposes them to major threats, due to littoral urbanization and industrialization, and also assigns them a significant yet uncertain role within the development of seaside tourism. These processes have resulted in a sharp increase in environmental pressures, besides the already widespread negative impacts produced over time by the gradual expansion of agricultural and pastoral activities. This leads to multiple situations of conflict related to the prevalence of the specific interests of different local stakeholders.

Many Sardinian wetlands disappeared for good during the late 19th and the 20th Century, mainly due to land reclamation processes, and many others are currently threatened or already affected and damaged by human activities. The vast land reclamation projects belong to the past and do menace these environments anymore, but many other major interventions are still likely to affect them, either directly or indirectly: overbuilding, channeling of rivers, water consumption for agricultural and domestic use, maritime infrastructures modifying sediment circulation, development of fisheries, creation of storage basins or lagoons for different kinds of discharges, etc. Moreover, other relatively widespread critical issues are related to summer fires, unlawful hunting and fishing, illicit disposal of waste, discharges of domestic, agricultural and industrial pollutants, encroachment of motorized vehicles in delicate areas, eutrophication, etc.

In many cases, these impacts have already severely damaged the ecological quality of these environments (Cannas *et al.*, 1998). The control on continental inflows (water and sediments), the maintenance of mouths and internal circulation, the regulation of the exchanges with the sea are management tasks that are essential not only to ensure the normal dynamics of fish migrations between sea and ponds, which is essential for fishing activities, but also for the very preservation of the environment as a whole (Cavallo, 2007; Lipu, WWF, 2003).

The wetlands of Cabras, Santa Giusta, S'Ena Arrubia, San Teodoro and Molentargius-Terramaini have been repeatedly affected, in recent years, by several episodes of large-scale mortality of the aquatic fauna. In these specific areas, the abnormal increase in fertilizers and nutrients, mainly due to discharges from urban areas and agricultural activities, including sheep and cattle livestock, causes eutrophication phenomena that alter the balance of all wetland ecosystems (Sechi, 1983). The discharge of pollutants in the wetlands has important and persistent environmental consequences, particularly when heavy metals and organochlorides enter the food chain. In addition to these threats resulting from industrial and agricultural activities, major risks are also related to sewage discharges, especially in the periods of peak tourist presence. Mining landfill, and abandoned mining sites in general, are another aspect of the problem, as in the case of streams which drain the landfills of the former mining district of Montevecchio and carry large amounts of heavy metals into the lagoon of Marceddì. Moreover, other activities, such as oil mills, dairies and intensive fishing, are other sources of pollution and can also inhibit the development of ecotourism.

5. Frailties

This synthetic overview shows the complexity and diversity of Sardinian wetlands. In-depth analysis of significant case studies with paradigmatic value can show the specific meaning of the experience of deconstruction of historical territoriality and the complexity of the process of constructing a new territoriality.

Fieldwork was done by the authors through several encounters with local stakeholders (within Local Agenda 21 processes, projects for tourism development, international co-operation, etc.) in the two areas of Cabras and Tortolì between 2007 and 2013 (Corsale and Sistu, 2009). The time of atavistic repulsion towards the wetlands in Sardinia seems to be gone and partly replaced by a widespread yet generic perception of attractiveness which is still far from producing strong territorial assets. The two case studies can actually be considered as an emblem of different opportunities offered by these particular resources and, at the same time, show the persistence of conflicting interests. Their story highlights the difficulties arising from the overlap of explicit institutional planning of the only partially formalized framework of local stakeholders' actions and interests.

The Regional Administration of Sardinia, thanks to its specific responsibilities regarding state properties, is the subject which determines the "prevailing vocation" of each wetland. In the case of both Cabras and Tortolì, the Regional Government focused on increasing fish production as the main asset, with a more recent inclusion of ecotourism, also linked with local food and wine traditions. These choices were made in contexts of strong contrasts among stakeholders. In fact, the management of fishing domains, which used to be a historical structural element of feudal power along the coasts of the island, is currently experiencing a period of heated territorial confrontation, as the end of the concessions granted by the Regional Government since the early 1960s must be renewed through public bids, according to the Directive 2006/123/EC ("Bolkestein"). This transition period, characterized by the issuance of provisional licenses and renewals, has resulted in an almost anarchical management of conflict situations.

5.1. Tortolì: a success story

The current pond of Tortolì, located along the Eastern coast of Sardinia, within the municipalities of Tortolì-Arbatax and Girasole, province of Ogliastra, occupies an area of 2.3 km^2 (Fig. 1).

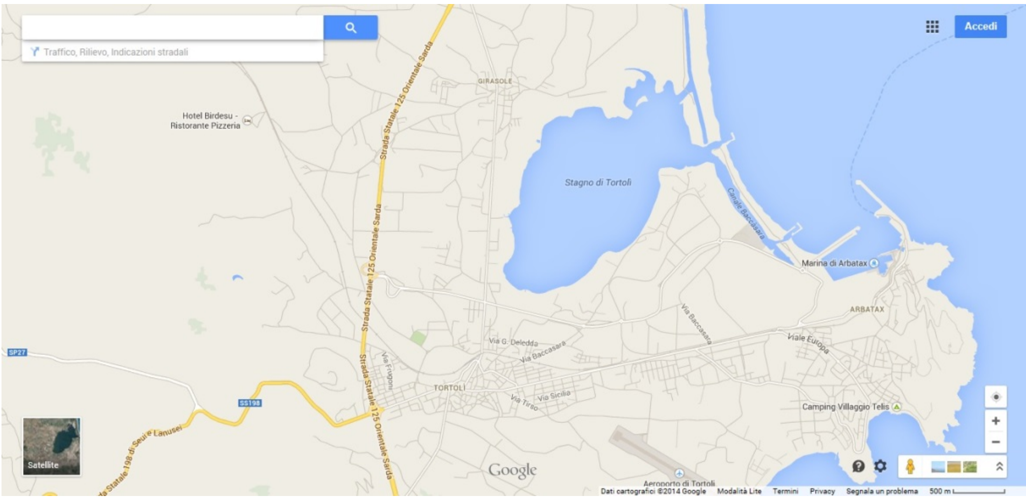

Figure 1. The Tortolì pond. Source: Google Maps.

Historical sources indicate that it used to be an open port in Roman times, while the current pond formed over the centuries through a process of gradual accumulation of continental sediments, favored by many hydrogeological processes. The pond and the connected fish farm were a feudal property until the early 19th Century, when it entered the public domain and was granted in concession to local individuals until the beginning of the 1950s. During this long period, the balance of the wetland was guaranteed by river freshwater inflows. The pond escaped drainage during the phases of malaria eradication which led to the loss of many Sardinian wetlands areas during the 20th Century.

The Fishermen Cooperative of Tortolì was created in 1944 by 13 founding members coming from Campania and Sardinia. By the end of the 1950s the number of fishermen reached 60 and they started a common struggle in order to obtain the removal of the holder of the concession, who anachronistically received 50% of the revenues of fishing. During the next decade the structure of the cooperative strengthened and their production grew, reaching the marketplaces of Cagliari.

From the second half of the 1960s, however, the process of industrialization along the Eastern coast of Sardinia started to impact on the wetlands through the construction of the enormous structures of a paper mill and a plant for the construction of oil rigs. Major changes related to the construction of these facilities led to the opening of new water canals and ultimately connected the pond to the sea turning it into a lagoon. At the same time, agricultural development required the construction of several dams within the river basins of Flumendosa – Mulargia, thus reducing the inflow of freshwater. The interference with industrial and agricultural development caused profound transformations in the characteristics of the ecosystem, including wildlife, with a rapid increase in the presence of marine species.

Facing these changes, the co-operative focused on the production of fish species with higher added value. At the end of the 1990s, the perception of the opportunities associated with the growth of new sensitivities in the regional tourism market led to the opening of a "kilometer zero" restaurant, which is permitted by the new Regional regulations on agrotourism (LR 18/1998). Following these innovations, the revenues for the co-operative currently exceed two million Euros per year. The original members have been joined by several employees, mostly family members of fishermen. Between 2007 and 2013, tourism linked to these new initiatives has recorded an average of 50 000 customers per year, a very significant value within the province of Ogliastra, where tourist arrivals do not exceed 130 000 and are usually highly concentrated in the summer months (80%) (Crenos, 2012).

Direct management of marketing, trading, catering and tourist fishing proved to be successful and the co-operative started operating in new directions, including environmental education, the creation of a new trademark for its most renowned products (including the typical bottarga, or mullet roe) and international co-operation (supporting development and collaboration projects in Brazil, Senegal and Tunisia). The average age of its members (38 years) has remained the same since 1998, in contrast to the advanced aging of the fishing workforce in many Mediterranean contexts.

However, the expiry of fishing concessions led to a difficult confrontation with the Regional Government. The release of a provisional concession until 2020 finally allowed to curb conflicts and prevented individual actions that may have altered the balance of the ecosystem. The success of the co-operative's strategies has been confirmed by the designation of its President to the presidency of the Group of Coastal Action of Eastern Sardinia, created in order to manage the local development actions of the European Fisheries Fund (EFF).

5.2. Cabras: opportunities and challenges

With its 3.6 km^2 hectares, of which 2.2 are submerged, the Cabras lagoon is the largest in Sardinia. It is located in the Western coast of the island, within the municipalities of Cabras, Riola Sardo, Nurachi and Oristano, in the province of Oristano (Fig. 2).

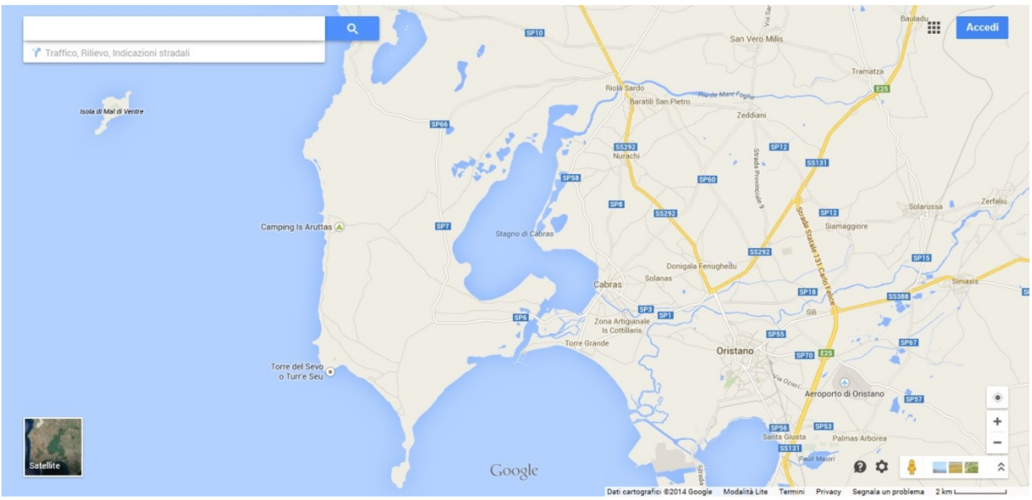

Figure 2. Location of Cabras Lagoon. Source: Google Maps.

Its configuration and the complex dynamics of its water flows make this environment particularly interesting, also considering its hydrobiological features and its flora and fauna. The drainage canals provide an important supply of freshwater. The lagoon opens to the sea through a diversion canal equipped with gates, distributing marine water to a system of channels which make the Southern part of the lagoon essentially brackish (Manca Cossu, 1990).

The pond proper is the hub of a complex system of wetlands located between the coasts of the Gulf of Oristano and the Sinis peninsula, partly protected by the Protected Marine Area of

Sinis - Isola Mal Ventre, a unique ecosystem because of the richness of its plant and animal biodiversity. The entire area is also protected by the Ramsar Convention.

The economic activities of the population of Cabras have historically been based on fishing, agriculture, crafts and livestock. In particular, fishing in the pond of Cabras is an important specific economic resource (85% of the fleet operates in the local pond, while only 15% is used for fishing in the sea) and is managed by 11 fishing co-operatives which consist of approximately 300 fishermen. The co-operatives belong to the *Nuovo Consorzio Cooperative Pontis*. In 1993 the Regional Government entrusted the consortium with the fishing concession for the area. Formerly, fishing used to be managed according to essentially feudal law until 1977, when the last "owner" of the lagoon died. Before 1977, a very rigid internal organization of fishing authorizations and functions created an unchanging social structure within the community. Different categories of fishermen and workers used to be given a complex set of functions: preparation and construction of reed dikes and dams, control of fish migrations, fishing, selling the product, etc.. The richness in fish stocks and the originality of local tools and techniques contrasted with an unfair distribution of the revenues, which caused severe social unrest (Fiori, 1961).

Following the sudden end of the exclusive fishing rights, the new co-operatives inherited a complex management system and faced the difficulty of creating an equitable and unified organization. The devastating large-scale fish deaths that affected the ponds of Santa Giusta (1989, 1994) and Cabras (1999), led many fishermen to apply for sea fishing licenses, in order to create an alternative to fishing in the lagoon alone. The main source of these crises was the alteration of the ecosystem caused by pollution and alteration of the water regime. The fish abundance in the ponds (historically about two quintals per hectare) has been severely affected by the effects of eutrophication produced by the discharge of untreated wastewater from industrial and agricultural activities.

The importance of these threats encouraged closer cooperation between the operators and the municipality of Cabras, which has produced an important process of diversification of activities through direct marketing of fish and processed fish products and the launch of fishing-related tourism activities, including a restaurant. In particular, tourism activities produced revenues for more than one million Euros in 2007, with over 45 000 customers. In the whole province of Oristano, tourist arrivals in classified structures are about 133 000 per year (Crenos, 2012).

However, elements of latent conflicts, recalling historical divisions, are still present. In fact, the expiry of the concession to the Fishing Consortium Pontis unchained the contradictions of this control model. The eleven co-operatives forming the consortium became progressively unable to mediate among the individual interests of the fishermen. As a consequence, about 80% of fishermen quit the co-operatives and started operating individually, without the necessary co-ordination that would ensure the environmental sustainability of their activities. Among the tragically negative consequences of this disbandment, in 2013 an unauthorized fisherman died during a clandestine fishing expedition, and, in the same year, the restaurant was destroyed by arson. Following these events, new mediation attempts by the consortium led many individual fishermen to join the grouping again and the restaurant was recently rebuilt and reopened. The perspectives are thus uncertain, with encouraging co-ordination efforts coexisting with persistently recurrent infightings.

6. New horizons

In conclusion, it is useful to focus on the weight that can be attributed to the political initiative in defining the perspectives for coastal wetlands. The action of a subject such as the European Union, which links protection, co-operation in research and development, the enhancement of non-codified knowledge, the legacy of history and the heritage of tangible and intangible knowledge coming from remote communities, is currently the highest standard reference in our field of interest. The measures implemented within the frameworks of LEADER and LEADER PLUS by Local Action Groups are a good example, as they aim at strengthening the role of wetlands' products as the result of the specific know-how of these territories; a process that, on the political level, appears to be the effect of synergies between institutional policies and actions of fragile wetlands' actors (Abram, Waldren, Macleod, 1997; Hannerz, 2001).

The experiences of Sardinia show that the integrity of a wetland depends on all the activities that are carried out: only integrated action, an "explicit institutional connection between protection and global governance of the territory" (Turco, 1983, 104), can preserve these values and the man-made environments that are related, given the historically symbiotic relationship between man and the lagoon; but it is also essential that all stakeholders have a voice and can help shaping the analysis of problems and aims. The same experiences also highlight the inconsistency in the definition of the value to be attributed to the local dimension of decision-making, within an institutional framework characterized by a highly centralized strategy. Besides the Regional institutional actor, the local political systems are still largely tied to a case-by-case regulation of the affairs of the territory and tend to keep a strong power of interference with respect to the application of general principles. Finally, the local communities, in addition to traditional technical knowledge and openness to innovation, seem to be able to act proactively within project choices, yet they are penalized not only by the contradictions of the intervention models but also by insufficient institutional support and the emergence of individual interests which are not always governed in a framework of appropriate mediation.

The comparison between the experiences of Cabras and Tortolì shows the efforts of the fishermen in capturing the value of the opportunities related to the positive transformation of the image of the coastal wetlands occurred in recent decades, through the strengthening of the ways and techniques of production, without harming the quality of wetland ecosystems. Their actions are important factors of attraction to specific resources in territories which used to be ignored by the regional tourism system. The differences between the two cases derive from different levels of conflict among the stakeholders. In the case of Tortolì, the presence of a single co-operative, and a management team which can negotiate with the individual needs, means that new initiatives were implemented with the consent of most of the fishermen. In the case of Cabras, the situation is more complex; the historic rivalry between the fishermen's co-operatives, a difficult legacy of the "feudal" past, has not been entirely overcome, and it is likely, in the absence of new rules for the use of shared resources, to give rise to new conflicts that could compromise the successes which had been reached in recent years.

The quality of the fishing activities and the connected activities is strategic; fishing and sustainable fish farming are largely compatible with the perspectives of conservation and local development, using tourism as a connective element. The actions of recovery and rediscovery of traditional methods of fish processing may become important factors of attraction in terms of experience for the regional tourism demand, also considering its teaching and educational dimensions. This unique natural heritage is a key element in the strengthening of regional ecological network. The growth of cultural tourism linked to the recovery and promotion of archaeological sites and museums located in the vicinity of some of the most important wetlands of Sardinia is one of the bases for further integration with the cultural history of these places, through active involvement of visitors in the historical knowledge; but only the integrated management of the ecosystem components of these fragile contexts can truly integrate tourism in the range of activities of local communities, without being overwhelmed by superficial museumfication.

The overlapping of projects related to recreation and tourism and the revitalization of fishing and traditions associated with it, along with widespread critical issues still related to the expansion of human activities in fragile coastal environments and to a persistently marginal socio-economic context, poses additional problems for the future. The analysis of these systems shows their changing character, through complex forms of relations among wetland environments and human societies, and highlights the potential and risks of locally managed planning.

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Drinking water(s) in Italy: Bottled, tap or kiosk water?

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The paper focuses on the different supply and consumption modalities of drinking water in Italy, with particular regard to bottled water (for whose consumption Italy ranks in the top of world ranking) and to the growing tendency of piped water supply offered by the so-called water kiosks. Production and management aspects, water quality parameters and peculiarities, environmental impacts of the two systems are investigated. The specific case study of water kiosks in the Friuli Venezia Giulia region is presented.

1. Introduction

Whereas too many regions in the world suffer from water scarcity or real water emergency, Europe, and particularly Italy, can afford to disregard the common tap water in favour of bottled mineral water, a choice that has become a general habit, notably for the young generations. In few cases, the consumption of bottled water is a safety guarantee for end users - peculiarly in areas where high concentrations of potentially harmful substances can be found in tap water - but in the great majority is not justified by any alleged bad quality of piped water. Moreover, the large use of bottled water brings about significant environmental impacts, at least considering the fact that about 80% of bottles are made by plastic, whose production, transportation and disposal give rise to well-known polluting processes.

As to drinking water, in the very last years a quite new tendency is arising in Italy, i.e. the choice, made by an increasing number of municipalities, of installing water dispensers – the so-called "Water kiosks" – that provide micro-filtered improved piped water, free or at cheap price. This paper intends to highlight figures, peculiarities, strong and critical points of two (somehow conflicting) systems of water supply: the market bottled water and municipal piped water, either taken from the tap or from water kiosks.

2. Bottled water consumption in Italy: comparing figures

In the last decades the incidence of bottled water ("mineral" and "spring" water[1]) in the overall drinking water consumption has generally increased worldwide, although with different

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The paper has been conceived jointly by the two authors. F. Battigelli specifically wrote par. 4, A. Guaran par. 2 and 3; par. 1 and 5 are in common.

[1] Since the difference between "natural mineral water" and "spring water" does not seem so clear it is useful to provide some information, with reference to the recent Italian law that regulate the sector of mineral waters. Section 2 of the Legislative Decree October 8th 2011 nr. 176 says: «We consider as "natural mineral waters" those waters that, originating in an aquifer or an underground basin, come from

figures from region to region. As regards Italy, such increase is particularly relevant in quantitative terms, but has interesting aspects from a qualitative point of view as well.

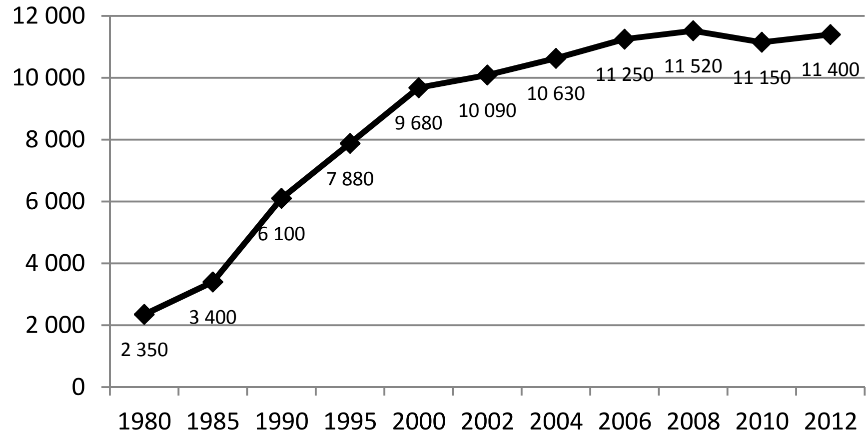

Figure 1. Mineral bottled water consumption in Italy (millions of litres). Source: Own elaboration from Legambiente-Altreconomia, 2011 and 2013.

The rising consumption of bottled water, whose trend is shown in fig. 1, regards mainly plastic bottles, particularly the one made of PET (about 80%), which is preferred nowadays to the traditional glass bottle. As to per capita consumption, from 1980 to 2012 the figure has increased from less than 50 to more than 190 litres per year, with a significant four times growth in the period. Although it has to be underlined that in the very last years the trend has tended to a stabilization, slightly diminishing to 192 litres per capita in 2012 in comparison with the peak of 197 litres in 1997, such data put Italy on highest ranking in Europe as regards consumption of bottled water: for instance figures are double when compared with the neighbouring Austria (85 l/pc), almost redouble the average values for UE countries (104 l/pc), and are even ten times more when compared with Finland, where the lowest value is recorded: only 17 litres per person (Table 1).

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one or more natural or drilled sources and that have distinctive salutary features and, possibly, properties that are advantageous for health.» Section 20 underlines that «We call "spring waters" those waters destined to human consumption, in their natural state or bottled, that, originating in an aquifer or an underground basin, come from a source with one or more natural or drilled openings.» According to the legislative definitions, spring waters are therefore a subset of mineral waters, whose peculiarity consists in being specifically destined to human consumption; they must be bottled in their natural state, directly from the source or in its close proximity and must maintain chemical and physical properties constant over time. The Italian law is the adoption of what the European Parliament has established in the *Directive 2009/54/CE of June 18th 2009 about the use and commercialisation of natural mineral waters,* specifically Sections 7 and 8 (Calà P. and F. Mantelli, 2012).

Table 1. Bottled water per capita yearly consumption in Europe: Countries in comparison. Sources: Legambiente-Altreconomia, 2013; www.efbw.eu/bwf.

Countries	Litres per capita (2012)
Italy	192
Germany	171
Spain	123
Hungary	118
France	112
Belgium	104
Austria	85
Poland	81
Romania	70
Bulgaria	66
Czech Republic	50
Estonia	31
United Kingdom	26
Finland	17

The Italian record is shown also on worldwide scale, since the per capita consumption of approximately 190 litres ranks Italy in second position after Mexico, where in 2011 the consumption was of 246 l/pc (which is six times above the average global data, around 30 l/pc/year)[1].

Analysing the Italian case from a qualitative point of view, there is no doubt that the investments and advertisements on bottled water have a strong effective impact, capable of catching more and more customers, especially among the young, who can find vending machines wherever they go, so that the plastic half-litre bottle of water represents nowadays something that can not be given up, whether at school, on a trip or at work. «The illusion of purity, the idea that water makes you younger, promotes diuresis, lacks in sodium etc...» (Altamore 2004, 17) thus appears to guide our choices concerning water consumption.

With regard to promotion and persuasion, it is also particularly interesting to comment the presentation made by the European Federation of Bottled Waters (EFBW) in its website, which refers just to the strengths of spring and natural mineral waters, when bottled and commercialized, while critical points are almost never considered. For instance, it is emphasised that mineral waters pumped from the underground are recharged by rain water and/or by the thaw, thus appearing like totally renewable (as if tap water were not a renewable, although limited, resource!). Furthermore, it is strongly underlined that the bottle label must always report the physical-chemical properties of water and information on the bottling company, that guarantees the consumer's safety; but unfortunately, what is reported on the label refers to analysis and authorizations that are not frequent at all, and in any case are in general less frequent and systematic than the monitoring carried out in the public water supply system.

[1] International figures slightly diverge (generally for a few litres) in the different information sources; for instance, the European Federation of Bottled Waters provides data which look downsized in comparison to the ones given by Legambiente (taken from Bevitalia-Beverfood), that refer to Italy. Generally speaking, since the figure of the worldwide average consumption is approximately one third of the European one, we can infer that the use of bottled water is very limited in the South of the planet, thus worsening, together with the chronic water deficiency, the access to safe water.

It is also interesting to consider the documentation that is provided by the EFBW about the comparison between tap water and bottled water. For instance, it is underlined that, whereas the «origin of natural mineral water or spring water can only come from a defined and protected underground area […], tap water can come from various sources including underground or surface water and waste water, and will usually travel long distances through pipes». Similarly, it is stressed that «natural mineral waters and spring waters must be safe to drink at source in their natural state, without disinfection, whereas tap water, on the contrary, is in general chemically treated, disinfected and chlorinated to make it safe to drink» (www.efbw.eu).

Leaving the aspects related to the image of the product, the advertisement campaigns and sophisticated marketing techniques, we would rather focus on the phenomenon of bottled water production and consumption, with specific regard to the costs of water exploitation fees.

3. The Italian bottled water industry

In Italy there are almost 160 mineral water bottling companies, that are present in the market with 280 different commercial labels distributed on the territory with fair uniformity (Fig. 2). The overall annual production exceeds 12 milliards of litres, the great majority of which (90%) is commercialized and consumed within the country.

Variations of the number of labels from year to year appear rather significant – both increasing until a decade ago, and decreasing in the very last period – while changes in the number of factories are understandably more limited, but still indicative. To give an example, in 2008 the bottling companies were 189 and the labels no less than 321, but a –13% decrease concerning bottling companies and –15.5% as regards labels have been recorded in the following five years. Such considerable reduction, whereas the production and the consumption can be considered rather stable, refers to the process of absorption of smaller and less competitive companies by bigger and more aggressive ones, or company merger, that can have taken place in the last years.

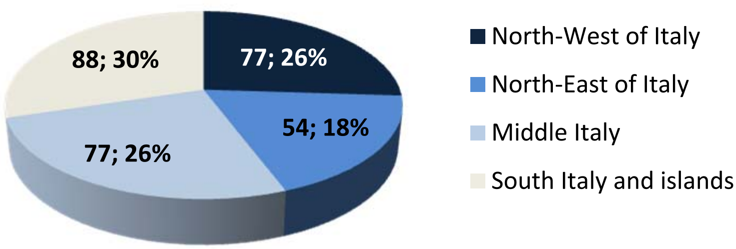

Figure 2. Bottled water labels in Italy by macro-regions (absolute and percentage values). Source: Own elaboration from Legambiente-Altreconomia, 2013.

As regards the different types of mineral water on the market, 64% is classified as natural or still water, 23% as sparkling (with CO_2 addition), the remaining 13% includes the naturally effervescent waters[1]. Thus, in Italy there is a higher consumption of still water, compared with

[1] All the reported figures are taken from Legambiente-Altreconomia 2013, that is based on the data of Bevitalia-Beverfood 2012/2013, and from Bevitalia surveys (Legambiente-Altraeconomia, 2013; www.beverfood.com).

the average EU data (58% in 2012). Nevertheless, sparkling water plays an important role in the diet of every Italian.

3.1. The controversial question of concession fees

A particularly relevant aspect regards the cost of water, which is generally insignificant for the bottling companies. First of all, it is worth to underline that the competence of mineral water exploitation in Italy is assigned to the jurisdiction of the regions, that are entitled to cashing concession fees as well. But, in spite of the decision made by the State-Regions Conference in 2006[1], the new regulations regarding fees have been only partially and slowly updated in the last years, and in very different ways in each region.

The criteria used to define the concession fees pertain three macro-categories, with reference minimum values established by national law: the surface, in terms of hectares of the exploited area (reference value: 30 €/ha), the volume of pumped water (reference value: 0.50–2.00 €/m^3) and the actual volume of bottled water (reference value: 1.00–2.50 €/m^3). Nevertheless the application of such criteria varies from region to region (Table 2). Whereas in some cases (e.g. Liguria and Sardinia) only the exploited surface is taken into consideration, conversely, there are regions that adopt simultaneously all the three criteria and with higher fees than the minimum established (e.g. Lazio). As regards the highest fees, the region that stands out is Veneto, where it was also decided to diversify the fees according to the morphology of the concession area, fixing the cost at 117 €/ha for mountain areas and 587 €/ha for plain areas (thus showing that it is possible to increase even significantly the 30 €/ha fee that is defined as the minimum threshold).

The considerable regional differences in the implementation of fees and their exiguity have recently made the association Legambiente complain that «the state of management and of payment of the (still very low) concession fees due for the exploitation of natural water resources has not improved and is not improving, thus allowing every company to achieve very high incomes and to maintain a large gap between their profit and the economic return for the communities living in the areas where the precious water is extracted» (Legambiente-Altreconomia, 2013, p. 13).

[1] According to the Decree of the President of the Republic n. 61/1977, that ratified the decentralization of the jurisdiction in the field of research and exploitation of thermal and mineral water resources, the regions should regulate the whole subject. Nevertheless, there are some regional administrations that still refer to very old legislations dating back to the period of the Italian Kingdom or to the early years of the Republic.

Table 2. Italian regions by fee parameters and values**.** Source: Re-elaboration from Legambiente-Altreconomia, 2013.

Parameters	**Conforming fees** (30 €/ha; 0.5–2 €/m^3 water pumped; 1–2.5 €/m^3 bottled water) or higher	**Non-conforming fees** (generally lower, also very low)
Surface	Puglia; Sardegna	Emilia Romagna; Liguria; Molise
Pumped water volume	Toscana	
Bottled water volume		Abruzzo
Surface + Pumped volume	Umbria	Sicilia
Surface + Bottled water volume	Calabria; Friuli Venezia Giulia; Lombardia; Marche, Province of Trento; Valle d'Aosta; Veneto	Basilicata; Piemonte
Surface + Pumped volume + Bottled water volume	Lazio	
Other criteria	Province of Bolzano	

3.2. Environmental impacts: some comments

Some remarks should be made about the environmental impacts that ensue from the common habit of drinking bottled water. It must be firstly considered that around three fifths of the bottles on the market are made with plastic (PET), obviously disposable. This packaging material implies for its production a large use of hydrocarbons - oil in particular - and considerable emissions of carbon dioxide, due to the double transportation of bottles (first empty, then filled), often on long distances. The PET life cycle has an environmental impact that can be easily calculated. For instance, the production of 1 kg of PET needed for 25 1.5 litres bottles (using 40 g of PET each) consumes 2 kg of crude oil and 17.5 litres of water (that means, no less than one half of the water that will be packaged); sulphur and nitrogen oxides, carbon monoxide and 2.3 kg of CO_2 are released in the atmosphere as well (FederUtility-AquaItalia-Anima, 2013).

Moreover, it has to be underlined that the waste disposal is rather unsustainable, considering that about two thirds of the bottles in Italy are still disposed in dumps or are incinerated, while only one third is delivered to a proper recycling process. Conversely, glass bottles, that in the past used to be the only containers, now are around 18% on the whole, mainly used in restaurants, as a quality element.

3.3. Bottled water vs. tap water: a comparison

Mineral waters, especially those that can boast the certification of "spring waters", are usually considered by common customers, inspired by uncritical confidence, excellent quality waters, exempt from all the health risks that water supplied by waterworks could involve. Actually, although the potential risks ensuing from the consumption of piped water appear sometimes to be relevant, especially in plain areas where intensive agricultural activities make use of considerable amounts of chemicals (weed killers, fertilizers etc.), however also mineral waters can be subject to quality worsening. In this regard, some years ago the consumers association Altroconsumo made an inquiry on national scale, analysing both samples of drinking water taken from public fountains in several Italian towns and samples of bottled waters from five well known labels of national relevance; the main result that turned out regards the presence of some contaminants in both types of water, although in small quantities, well below the safety limits established by law. Despite such overall reassuring results, it emerged the unquestionable fact that all water, both bottled and piped, can contain traces of potentially dangerous contaminants, so that the actual conclusion is that «purity is a quality that becomes rarer and rarer and no product can be considered to be exempt from environmental contaminants» (Altroconsumo, 2009).

3.4. The bottling industry in Friuli Venezia Giulia

In the case of Friuli Venezia Giulia, a region that lies on the extreme North-east of Italy, the regional government issued in 2010 a regulation that establishes the concession fees for the exploitation of mineral waters according to the parameters of exploited surface and bottled water volume[1]; such fees have been fixed respectively at 30 €/ha and 1 €/m^3, thus complying just with the minimum established by the national law. These very limited values engender only a slight income for the regional administration, while affect the bottling companies' production costs in an incredibly low measure, as it can be calculated that only around 0.4% of the overall revenue of the companies is allocated to the payment of the concession fees.

The following four bottling companies are working in Friuli Venezia Giulia: "Goccia di Carnia", whose water catchment plant is located in Pierabech (Forni Avoltri, Udine Province), in the alpine area, at 1370 meters a.s.l.; two companies are located in the Carnic Prealps, their sources both lying at 650 metres a.s.l.: "Dolomia", located in Valcimoliana, in the municipality of Cimolais (Pordenone Province), and "Pradis", located in Pradis, municipality of Clauzetto, (Pordenone Province); and finally the source "Paradiso" (Pocenia, Udine), which is the only one in the low plain area, at 12 meters a.s.l.

Thanks to the favourable mountain location in the catchment areas of the three companies "Goccia di Carnia", "Dolomia" and "Pradis", a very low dry residue and mineral content are found in their water (0.1–0.2 g/l), when compared with other medium-content Italian waters (0.2–1.0 g/l) or with mineral water in the strict sense (values above 1.0 g/l). But also "Paradiso" water maintains values that are unquestionably ascribable to good quality (0.3 g/l)2.

4. Fostering "Mayor's water": appearance and upsurge of Water kiosks

In the very last years a new kind of "fountains" is appearing and rapidly spreading in cities and villages in Italy, the so-called Water Kiosks ("Chioschi dell'acqua" or "Case dell'acqua"). Re-proposing the traditional role of supplying public freshwater, the descendants of the old fountains are modern devices that dispense water – still or sparkling, chilled or at ambient-temperature – at the price of few cents.[3]

4.1. How the kiosk works?

Kiosk water is taken from the municipal network, therefore it maintains the same controlled quality as the tap water ("the Mayor's water"), but it gets improved organoleptic characteristics

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[1] Friuli Venezia Giulia Region, *Legge Regionale 23 luglio 2009, n. 12* ("Regulation for the definition and the implementation of the fees related to the concessions for the research and the exploitation of mineral, thermal and spring water basins, pursuant to and in accordance with Sect. 4, par. 4 of the Regional Law n. 12/2009"), in «Supplemento ordinario Bollettino ufficiale regionale», 29 luglio 2009, n. 018.

[2] Data are taken from www.friulitipico.org/prt/cibi-e-bevande-mainmenu-26/acque-minerali-mainmenu-27.html.

[3] Water kiosks are a common device in many countries which suffer from water scarcity or with precarious access to freshwater, notably in Sub-Saharian Africa, e.g. Zambia, Kenya, Tanzania, Cameroon.

as it can be carbon-added and chilled. The plant is usually composed of these basic elements: a pressure regulation valve, active-carbon filters for removing micro-pollutants (>50 micron), UV-rays filters for disinfection, a supply section with a gauge for metering water drawings, an electric pump for activating the water flow, the connection to a remote control system. In addition to normal water, the supply section can provide carbonated and cold water, in such cases being equipped with CO_2 cylinders and a refrigeration system. Often enough, the electricity supply for the whole plant is provided by photovoltaic panels.

Water drawing is activated through simple buttons or electronic sensors, the flow speed being from 2 to 6–8 l/minute. The dispenser has developed into safer and safer types, from basic water mouths or faucets to recessed nozzles that prevent hand contact. Disabled and wheelchair access can be provided, as well as swig drinking facilities in kiosks located in parks and sport grounds. Through remote control a cycle of sanitization is operated every night in the whole plant in order to hinder bacterial re-growth.

The physical structure of the kiosk can have different shapes and a great variety of architectonic solutions (Fig. 3): from plain wood canopies and brick or stone stalls to closed or semi-closed booths and more complex structures. Attractive design architectures, made with modern materials and even embellished with funny drawings or art decorations can make the kiosk a visible and appealing point of interest, a kind of local landmark.

Figure 3. Two samples of water kiosk.

4.2. Water kiosks in Italy

Since the last two-three years water kiosks in Italy have been rapidly increasing in numbers across the whole country. Several factors are triggering such new phenomenon: it is undoubtedly connected to a growing awareness among the general public about water resources conservation, and it can be a matter of image and consensus for local administrators, while the imitation factor is a major driving force as well[1]. Such social bias entails economic aspects too,

[1] A new general tendency for the enhancement of piped water is developing in Italy, which increasingly involves private citizens, public administrators and environmental associations. Such multi-actor movement - whose campaigns are promoted with imaginative names such as "L'acqua del Sindaco" ("The Mayor's water"), "Imbrocchiamola" ("Let's use the pitcher"), "Drink City" – aims at orienting the consumers' habits towards the use of tap water in place of more expensive and impacting bottled water. A leading role in this campaign is played by the mayors of an evergrowing number of municipalities, who decided to replace bottled water with tap water in all city government's meetings. Presently, the "Mayors

as a profitable, new niche market is developing for small manufacturing and managing businesses working in the sector of drinking water supply.

Unfortunately, it is troublesome to assess the actual figures of the existing water dispensers in Italy, given the lack of a national accounting system of such a novel sector, the great variety of operators involved and the swift increase of managing private firms, which are somehow difficult to record. The sole available national-level overviews have been made by the Italian association of water-facility companies (FederUtility-AquaItalia-Anima, 2013), although they look definitely under-estimated[1]. Nevertheless, such surveys highlight the extraordinary upsurge in the number of water kiosks in Italy, that have increased by 130% in only two years, being calculated over eight hundred in 2013.

Scaling down to the regional level, according to the mentioned surveys three Northern regions are top-ranking in Italy as to number of water kiosks installed: Lombardy, Emilia-Romagna and Piedmont, followed at a distance by Tuscany and Veneto.

A crucial and delicate matter regarding the supply of kiosk water is pricing, since a fair as well as a convenient price must be accurately balanced between public advantage and the recovery of costs and profit margin for the private companies, in order to provide an economically sustainable public service. Therefore, water prices to the end users are always agreed upon between the ordering public institutions (usually the municipalities) and the installing and managing private businesses.

In regard to such aspect, according to a cost analysis that has been formulated in a recent economic research (Torretta, 2013), the kiosk operating cost in a medium-sized Italian town is estimated around € 42600 per year, the most expensive items regarding maintenance and replacement of filters (which have an incidence of 59% on the overall cost) and CO_2 supply. All considered, the annual operating cost of water dispensers is reported to break even at a sale price of 0.02 €/l for still water and 0.03 €/l for carbonated water, or, alternatively, 0.05 €/l for sparkling water and free still water.

4.3. The study case of Friuli Venezia Giulia

An in-depth survey has been done in 2014 by the Regional Government of Friuli Venezia Giulia in order to investigate the new rising phenomenon of water kiosks, with particular interest for its effects on the production of waste (Regione Autonoma Friuli Venezia Giulia-Anima, 2014). The municipalities, the concerned public utilities and the kiosk manufacturing companies in the region have been thoroughly queried, from which data the following interesting figures have come to light. In 2013, the water dispensers in the region numbered 79, the most part (60) being located in the Udine province (seven in the town of Udine). Altogether, the kiosks supplied the appreciable quantity of more than 19 million litres of water in the year, of which 78% in the province of Udine.

The plant ordering subjects are usually municipalities and water public utilities; but also private businesses are starting to offer such service to their clients, as in the case of some

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for Water" network can rely on a large part of the Italian big cities (e.g. Roma, Napoli, Venezia,) and on an increasing number of medium and small towns all over the country. Within this contest it lies also the interest and the support local administrators are showing towards water kiosks. For further information see www.acquabenecomune.org; www.legambiente.it/contenuti/campagne/imbrocchiamola.

[1] It is the case, for instance, of the Friuli Venezia Giulia region, where only eight kiosks are counted in 2013 by the mentioned survey, when compared to a much higher real number, as is shown further down (see par. 4.3).

drugstores in the town of Udine. The production and the installation of the facilities is mainly made in the region by two private companies (Overland srl and BBTec srl) that usually run the technical management as well, whereas only few cases are managed with public utilities' in-house modality.

It is interesting to analyse the timing and the diffusion process of the new technology in the region. The very first kiosk has been put in place not before January 2011 in a shopping centre in the Udine outskirts. It took just some months for emulating such experiment with a number of new installations in the town of Udine and the neighbouring municipalities; and in the following years the new practice soon propagated in many small towns of the Udine province, afterwards in the Pordenone area and, in 2013, in the Gorizia province. The distribution map (Fig. 4) shows clearly that the kiosks are polarized in the plain and the hilly areas around Udine, while the whole mountain area (in the northern section) and the small province of Trieste are not interested at all.

Figure 4. Distribution of water kiosks in Friuli Venezia Giulia (Source: Regione Autonoma Friuli Venezia Giulia-Anima, 2014).

With regard to economic aspects, the installation cost (which is only given in the case of the public utilities) ranges from € 14000 to € 23000 in average, with a few peaks of € 50000 in some multi-function plants. The price of water for the end user is € 0.05–0.07 per litre for carbonated water, while still water is free (for the most part, and in all kiosks managed by public bodies) or costs just 0.01–0.03 €/l; such fees are within the breakeven range calculated by the cited economic research (Torretta, 2013). The end user can pay the amount with coins or, more commonly, with a key or a prepaid magnetic card.

Postulating a direct relationship between the volume of water taken from the dispensers and a reduction of bottled water, a widespread use of kiosk water implies a number of benefits. Clearly, for the end users there is a significant economic saving: given the price of bottled water (0.20–0.30 €/l according to brands), a four-person family which drinks the average 190 litres per person can potentially save yearly around € 150 for sparkling water, or somewhere about € 230 in case of (free) still water. And definitely positive is the environmental effect. Generally speaking, as bottled water is mainly packaged in plastic (PET-Polyethylene terephalate), although with decreasing quantity of raw material per bottle (e.g. just 12 grams of PET for half-litre bottles, 40% less than the average quantity a few years ago), non-use of bottles means a saving of plastic production, a reduction of CO_2 emissions for bottle production and distribution, a decrease of plastic waste disposal. With regard to Friuli Venezia Giulia, the regional survey has calculated that a saving of no less than 540 tonns of plastic and 3570 tonns of CO_2 ensues from the 19 320 000 litres of zero-kilometre water supplied by the kiosks in 2013 in the region[1].

Figures regarding per capita consumption of water drawings from the kiosks can have significance only for small municipalities, where one or two plants can serve the whole population. Nevertheless, a correlation between time of installation and quantity of dispensed water can be hypothesized: e.g. the Friulian municipalities that are served by the first installations usually have higher and very significant per capita consumption, around 90-100 l/year.

In the short-term, a further expansion of kiosks can be foreseen in the region (by way of example, nine new facilities will be installed in the town of Udine in 2014); and the offer itself is going most likely to enlarge, by combining water with other unpacked dispenser-supplied basic products such as fresh milk and detergents, as is already the case in some water kiosks in the Pordenone area.

No doubt, in the short-run the supply growth is forecast to affect the demand in a virtuous circle, thus contributing to change the consumers' habits as to water procurement.

4.4. Discussion

As a matter of fact, water kiosks can be considered a sort of hybrid between public service and private business. This involves the crucial and contentious debate about water as a right or a commodity and, consequently, about the claim of public financial support to kiosk plants. As regards this matter, arguments are arising in particular in Lombardy, where the regional government has recently issued an act (N. IX/2553 of November 24, 2011) by which a € 800.000 fund has been allocated to the Lombard Provinces and the municipality of Milan as a contribution for the installation of water kiosks, intended as a means for sensitizing people to reduce the consumption of environmentally impacting bottled water.

According to some commentators (Sileoni, 2012), any public support to water kiosks is to be considered unjustified and unfair, due to the following reasoning. The basic right to water is guaranteed to every citizen by public utilities, that supply freshwater to all houses; consequently, the water kiosks can not be regarded to as an essential service of public interest but should be considered in a market logic as an entrepreneurial activity, that has not be backed with public funds that would affect unfairly the free market competition. Besides, promoting the use of city water as a way for sparing the cost of an alleged more expensive bottled water

[1] Actually, a correct environmental assessment should take also the impact of the technical management of the dispenser facilities into consideration, notably with regard to the environmental cost stemming from the disposal or regeneration of the used filters that must be frequently changed (Torretta, 2013).

sounds as an incorrect and misleading message, provided that the two types of water have different organoleptic peculiarities and are not equivalent. Therefore, water from kiosks should not be considered an alternative to bottled water but a third complementary offer, consisting of improved (filtered and carbonated) tap water. Anyhow, to conclude this part, leaving such debate aside and recalling the need for a more systematic monitoring of this new phenomenon, it is the author's belief that the water kiosks can play the important role of disseminating a new water culture and educating the general public about the need for respecting, protecting and sparing a vital as well as a limited and irreplaceable resource.

5. Conclusions

The paper has shown how the market of drinking water in Italy is changing in the last few years. The consumption of bottled mineral water, although constantly in the top of world rankings, is facing a slightly decreasing trend, while a quite new modality of enhancing the use of piped water (the so-called "Mayor's water") comes from water kiosks, that can supply improved tap water and that are rapidly spreading across the country. The paper has investigated these modalities of water supply, focusing on production and management aspects, water quality parameters, resulting environmental impacts. In particular, evidence has been given about how the water bottling industry in Italy, notably in a number of regions, can benefit from very low concession fees, thus gaining large economic benefits. On the other hand, the diffusion of water kiosks, although beneficial in terms of reduction of the environmental impacts deriving from the production, transportation and disposal of plastic bottles, shows the need for a deeper reflection regarding the opportunity of supporting a (normally private) business with public funding.

Such considerations recall the long-disputed debate about water – how to match a basic right to drinking water, to be fulfilled by public institutions, and the demand of a low-cost market commodity issuing by private economic subjects. As to Italy, the paper has pointed out, on the one hand, the fragmentary nature of the regulations regarding water exploitation, and their late, confused and uneven implementation in the different regions, and, on the other hand, the wide margin of action granted to bottling companies, which show no intention to renounce to the logic of market economy in the name of a principle of conservation and sustainable use of a common good, water in this case.

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Urban water damages in Pécs triggered by extreme weather events

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The study analyses urban hydrological cycle related hazard map for Pécs in association with torrential rainfalls with a special focus on the May and June, 2010 rainfall events. A cutting-edge approach which simultaneously reveals the hydrologic and geomorphologic issues of extreme weather events is developed. The analysis identifies the terrain, land use and infrastructural circumstances which may play a crucial role in evolving urban geomorphology-related damage. To mitigate losses new urban design techniques need to be introduced as well city authorities should map stream reaches and urban watersheds to locate the potential sources of damage.

1. Introduction

Urban hydrological issues are very complex. There are multiple human, infrastructural and environmental factors that may contribute to the hydrologic consequences of torrential rainfalls and other extreme weather phenomena. For example, infrastructural damage may affect roads, stormwater sewers, ditches, culverts, retaining walls, levees, dykes, embankments, bridges and enforced stream banks (Kerle and Alkema, 2012). Properly maintaining these human-made hydrologic and slope-stabilization structures is essential in order to manage stormwater and urban environment in general from a hydrologic point of view (Douglas, 2005). The plethora of contributing factors is further exacerbated by the heterogeneous spatial and temporal pattern of urbanization-generated geomorphologic processes (Gregory and Madew, 1982).

An urban watershed can be analyzed in a complex way according to its risk potential if the contributing environmental and human factors are parameterized (Gupta and Ahmad, 1999). By mapping these environmental and anthropogenic parameters with GIS tools, a watershed-based hazard map can be generated that will provide a rapid analysis for areas where drainage and other problems may occur. Increased surface of impervious areas will decrease infiltration, hence, increasing surface runoff and water loss due to evaporation. To mitigate urban floods due to excess stormwater runoff, efficient drainage and water retention capacity need to be increased. Built-up areas on the surfaces of high relief are especially prone to catastrophic floods. Pécs, SW Hungary is a fine example of such developed areas (Czigány *et al.*, 2010). Pécs has been affected multiple times by excess stormwater runoff causing severe losses to the infrastructure of the city (Lóczy and Gyenizse, 2010). However, the majority of the hydrology-related losses were the direct consequence of the poor maintenance of urban infrastructure.

The main goal of our study is to generate an urban hydrological cycle related hazard map for Pécs in association with torrential rainfalls with a special focus on the May and June, 2010 rainfall events. The current study highlights a cutting-edge approach to the topic which simultaneously reveals the hydrologic and geomorphologic issues of extreme weather events.

2. Materials and method

2.1. Study area

The study area is situated in Pécs, SW Hungary. The city is located in Pécs Half basin, which is formulated by the southern foothills of Mecsek Mountain and the gentle slopes of the South Baranya Hills. The majority of the city belongs to the upper section of Pécsi-víz watershed. This part of the stream is strongly influenced by the anthropogenic effect of urbanization (Ronczyk and Lóczy, 2006). The stream network has been completely turned artificial over the last two centuries; however, due to the diverse topography of the study area stormwater management, flood prevention and slope stabilization are still existing problems. The headwater of the Pécsi-víz, within the administrative borders of the city, is traditionally divided into 13 subcatchments (Buchberger Mérnöki Iroda Kft, 1994). Eleven watersheds out of the 13 are located on the steep, densely built slopes of the Mecsek Hills while the remaining two watersheds are found in the hilly part of the city south of the Pécs Basin. The current study primarily focuses on the mountainous northern part of the city, the core area of city development, which was damaged by the heavy rainfalls during the last years.

2.2. Datasets

The datasets analyzed are divided into two major parts. The first dataset is metadata which is derived from the digital elevation model (DEM) of the studied area. Such principally raster based datasets include slope, relief and watershed delineation. The second group predominantly includes vector-based data. This dataset is either the result of the raster vector conversation or is derived from the cadastral dataset of local authorities. The cadastral dataset primarily deals with urban geomorphological data, including the location of retaining walls, storm sewers, sealed riverbeds, culverts and other urban landscape geomorphic data.

Land use and land cover data (LULC) were taken from the digital database of the European Environmental Agency that was developed in 2009 (EEA, 2010). Other data regarding the reported and recorded damage to the slope-stabilizing and hydrologic structures used for disaster prevention were provided by the Pécs Mayor’s Office for the period of May and June, 2010.

2.3. Methods

The aforementioned datasets were evaluated and analyzed in the ArcGIS 9.3 software environment. The delineation of individual sub-catchments was carried out with the help of ArcHydro, a built-in hydrological tool for ArcGIS. The spatial correlation between the damages triggered by extreme weather and the urban geomorphological character of the subcatchments were determined with the overlay functions of ArcGIS 9.3.

3 Results

3.1 Classification of urban geomorphological damage caused by heavy rainfall

Extreme weather phenomena significantly contribute to the increased rate of geomorphologic processes today (Szabó, 2010). The increased potential of surface runoff impacts the surface (and subsurface) in multiple ways and may result in catastrophic economic and social consequences. During urban planning it is of primary importance to reduce, or at least mitigate, the undesired impact of geomorphological processes (Gyenizse and Ronczyk, 2010). Despite the considerable advances in urban planning and engineering, unmanageable urban challenges still exist at the current level of economic and technical development. The challenges, however, are usually rooted in the complex physical, social and economic processes that drive urban development. In most cases, the disharmony of the human impact on the natural landscape is the responsible factor for the excess geomorphological damage related to runoff (Hollis, 1997). Nonetheless, such disharmony essentially needs to be compensated for by appropriate infrastructure and edifices. Drainage ditches, channel systems, bridges, culverts, dykes, levees, retaining walls and sink fills more frequently appear in the urban environment, including Pécs, which adjusts the surface to human demands. The aforementioned stabilizing and flood prevention edifices provide, or at least aim to maintain, a balance between the exogenic geomorphological processes and the manmade environment and also mitigate the magnitude of mass movements. Temporary stabilized sealed surfaces may require continuous maintenance or subsequent development and upgrading according to the appropriate technical level and planning practice. Nevertheless, extreme weather phenomena often foresee the direction and magnitude of the required future developments and pinpoint the necessary aspects that should be considered during the planning and development of risk mitigating edifices and structures. In the current study, we systematically classify geomorphological damage that was observed during the May and June extensive rainfall events. The observed risk and damage types and factors are classified according to their spatial impact scopes into (1) surface and (2) subsurface categories (Table 1).

Table 1. Definition and types of stormwater related damages in Pécs.

Risk definition	Description
Surface	
Bank erosion	Heavily undercut and eroded stream, river banks and ditches (both paved and unpaved)
Flooding/inundation	Coverage with surface water during excess runoff
Ponding	Surface water accumulation behind levees and dykes due to hindered drainage
Sediment accumulation	Deposition and accumulation of sediments and debris due to decreased velocity and energy of running water/flood water
Pavement damage/scouring	Impassable roads/sidewalks/driveways due to excessive damage to the paved or covered surfaces
Damage to bridges	Collapse of bridges, or serious damage to the base of the bridge
Subsurface	
Damage to retaining walls	Undercut retaining walls, collapse of walls
Boils/temporary springs	Water upwelling due to excessive hydraulic pressure during floods, primarily along levees and dykes
Collapse of underground structures	Collapse of cellars, scouring of underground edifices, collapse of tunnels with distant heating pipelines

3.2 The impact of flooding in Pécs in May and June, 2010

In identifying and recording the damage, we considered the period between May 16, 2010 and June 5, 2010. The reported damage required immediate action and intervention and its generation is unarguably associated with the observed extreme weather phenomena of the period. The majority of the stormwater related losses occurred in the high-elevation watersheds of the city characterized by rugged terrain (Fig. 1). During the current study, only those losses have been considered which were officially classified as weather related *vis major* disasters by the Pécs Holding Company, the predecessor of the current city management company BIOKOM Ltd. The list includes 49 disasters out of which nine events generated extremely high economic losses and restoration costs. In these cases, restoration costs were covered from the national *vis major* financial fund. The predominant type of damage was bank erosion that resulted in the severe erosion of retaining walls (16 cases), and, as a consequence, local watercourses overflew their streambeds at multiple locations. The second most common type of observed damage was the erosion of paved and sealed surfaces (12 cases). In this case, several gravel, dirt and stone roads became impassable (Fig. 2). The general conditions of nine retaining walls were severely deteriorated, becoming close to complete collapse, requiring instantaneous restoration works. In seven cases, newly evolved upwelling waters and springs were observed. In three cases, significant ponding was reported, requiring intense pumping. According to field reports and records, two bridges became unusable. Fortunately, the most intense and devastating flash floods in the city did not result in loss of human lives, even though peak discharge values occurred during early morning hours.

After the review of the analytical tables that include geomorphic and land use parameters as well as data on the damage caused during the period discussed (Tables 2 and 3), we found no significant correlations between the geomorphologic parameters, land use data and the damage caused by the extreme weather events. The length of human infrastructure increases obviously along with the ratio of the urban fabric percentage of land use,. Further multivariate statistical information needs to be employed to highlight the deeper coherence between the different types of databases.

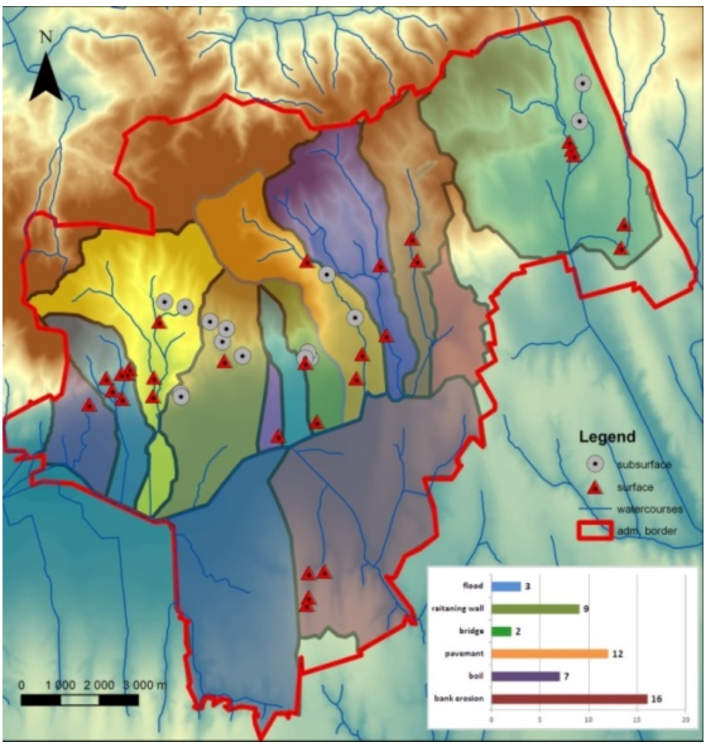

Figure 1. Types and location of reported losses during the May and June, 2010 flood events.

Figure 2. Various types of flood-triggered losses in Pécs and in its vicinity May 15 and 18, 2010; photos (a) to (c) were taken in Pécs, picture (d) was taken in Sásd, about 30 km to the north of Pécs.

Table 2. Selected geomorphic parameters and types of damages in the subcatchments of Pécs.

Name of subcatchment	Geomorphic parameters							Damages					
								Surface				Subsurface	
	Territory (km^2)	Average high a.s.l	Highest elevation a.s.l	Absolute relief	Average slope	Average relief in 100 m	Highest relief in 100 m	Bank erosion	Flooding	Pavement souring	Bridge	Boil	Retaining wall
Disznóhízlaldai	3,4	183	542	436	6,1	12	42	1	-	-	-	-	-
Patacs Stream	4,6	257	577	463	7	17	46	**3**	-	**3**	-	-	-
Magyarürögi	**14,1**	306	**610**	**496**	10,4	**21**	71	2	-	2	-	2	-
Új Fűzes	9,6	201	576	462	5,8	12	53	1	-	-	-	2	**4**
Hunyadi úti sewer	2	239	529	410	7	14	49	-	1	-	-	-	-
Új Tettye ditch	2,3	258	529	408	7,7	16	59	-	1	1	1	1	3
Lámpás Stream	8,5	**335**	**610**	483	**10,7**	**21**	105	**3**	-	1	-	1	1
Meszes Stream	11	282	482	336	8	17	70	1	-	-	1	-	-
Szabolcs	8,7	280	412	246	7,6	15	**110**	2	-	-	-	-	-
Vasas-Belvárad	55	289	454	293	5,9	12	97	**3**	-	1	1	**2**	1
Nagyárpádi	30,6	171	226	106	3	6,4	34	-	1	**3**	-	-	-

Table 3. Land use types and selected infrastructural parameters in the subcatchments of Pécs.

Name of subcatchment	Land use (%)					Human infrastructure (m)					
	Forest	Agricultural	Urban fabric	Industrial and comm.	Roads, railways	Retaining walls	Levee /dyke	Bridge (number)	Sewer	Stream / ditch	Sealed stream
Disznóhízlaldai	14	**44**	23	12	5	5581	2479	44	1948	5218	1023
Patacs Stream	40	24	24	6	4	1537	5393	48	3391	6630	1129
Magyarürögi	**54**	11	30	< 1	3	26466	6055	95	627	10436	1834
Új Fűzes Stream	10	17	**44**	17	8	**57896**	9636	36	**42158**	7923	**7207**
Hunyadi úti sewer	19	1	30	**35**	**10**	21367	0	5	7097	617	6
Új Tettye ditch	38	3	27	18	8	18618	0	26	5111	2668	1558
Lámpás stream	48	17	22	7	4	26333	728	51	5537	9095	1477
Meszes stream	53	8	18	6	3	10374	0	**102**	5377	14492	0
Szabolcs Stream	51	17	19	6	4	17444	1483	92	4465	9514	154
Vasas-Belvárad Stream	49	33	10	2	2	8153	34	41	1926	**35382**	2101
Nagyárpádi Stream	15	49	15	14	4	6855	**9823**	65	6639	21051	2930

3.3 Flash flood-triggered losses

Flash floods, primarily due to poor infrastructural maintenance and improper engineering caused the most severe problems within the city, especially in the Vince and Május 1. Streets. In the Vince Street in central Pécs, drainage-hindering factors had been formerly present (i.e., clogged drainage filters). However, due to an ignored and neglected maintenance protocol, the severity of the May and June, 2010 events triggered the culmination of the problem and intense flooding in the Vince Street. The undrained surface runoff profoundly eroded and scoured the road surface there, depositing about 50 cm of sediment at the lower end of the street in the Ágoston Square (Fig. 3). These undesired processes necessitated the immediate restoration of the drainage passages in order to prevent loss of life and excessive damage to the houses in the Vince Street.

Another example of urban flash floods triggered by heavily altered land use by coal mining activities during this event occurred in the eastern part of the city in the Május 1. Street. Active mining took place in the headwaters of the Meszes Stream which flows along the Május 1. Street. Due to the open-pit mining in the headwaters of the watershed, a dyke embankment was built along the creek with a road on top of the dyke. Here, a culvert of 100 cm diameter conveys the water underneath the dyke. By May 15, 2010 the culvert was completely clogged with debris, communal waste and branches. A hydraulic head of 20 m was formed behind this dyke. The high hydraulic head unplugged the culvert and let the water flow through the culvert, inundating and sweeping through the Május 1 Street. About half a million m^3 water inundated the street, causing losses of about 2 million Euros. The water damaged houses, pedestrian bridges, overtopped several cars, destroyed reteaming walls and made seven properties inaccessible. The street itself became impassable for any type of vehicle, including fire trucks and ambulance vans.

Figure 3. Damage and losses in the Vince Street on May 17, 2010. (a) the clogged drainage filter at the northern end of the street; (b) and (c): the damaged road surfaces; (d) the accumulation of deposits at the southern end of the street and the Ágoston Square

4. Conclusion

The current study points out the importance of systematic data collection and data exploration which need to be employed to highlight the most important factors of the urban geomorphologic consequences of torrential rainfall events. Our analysis identified the terrain, land use and infrastructural circumstances which may play a crucial role in evolving urban geomorphology-related damage; nonetheless, lack of appropriate infrastructure maintenance could be one of the core components of undesired hydrologic and geomorphologic processes. To avoid or at least mitigate losses, inevitably, new urban design techniques need to be introduced while, at the same time, city authorities should map stream reaches and urban watersheds to locate the potential sources of damage. A complex mapping of this type would require a thorough GIS based analysis of flood and excess runoff contributing factors responsible for increased infrastructural losses. One solution to decrease or mitigate urban excess runoff would be the widespread application of sustainable stormwater management approaches. This would mean the introduction and maintenance of engineered solutions that aim to mimic natural drainage systems and processes. Such facilities would use permeable surfaces, including soil and vegetation, to filter, absorb and moderate the flows of runoff. Such low impact development (LID) techniques would also reduce the pollution of watercourses and localized flooding as well as provide amenity and biodiversity benefits (Hinman, 2005). Green roofs, bioretention swales and permeable pavements are the most common methods of controlling stormwater in urban areas.

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Flood risk assessment – a basis for sustainable spatial development Case study: the Republic of Bulgaria

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Statistical data and risk analysis from the recent decades clearly and undoubtedly show an escalation of the damage caused by floods – damage on human health, casualties, economic and environmental losses (the major floods in Austria 2005, 2009, United Kningdom 2013, etc.). The growing number of the global population faces the problem of the limited available space for development. In addition to this, natural hazards, like flood hazard exert pressure on the existing and potential development areas. Humanity has become more vulnerable to the flood exposure and the risk has increased significantly. The high damage potential – human health, economy and environment – is a serious challenge for the achievement of the sustainable development objectives. Therefore, strict regulations should be introduced in the territorial planning and spatial development so that flood damage is optimally reduced. Flood risk management plays a key role in sustainable territorial development, representing a mechanism for land use regulation considering the flood probability and extent.

1. Introduction

In the last four decades, natural disasters have created a lot of suffering and great economic losses. The increase on disaster losses and reconstruction cost can hinder spending on other sectors such as education and health, thus reducing capacity of government in sustainable development. Therefore, reducing disaster risk, therefore, should be aimed at the development of resilience community to natural hazards and ensuring that development will not increase further vulnerability of community and infrastructures. (UNISDR, 2001). Spatial planning is increasingly regarded as one of the important instruments in disaster risk reduction. It facilitates decision on the future use of space in any administrative unit, which in some cases may be confronted by natural hazards. This would be an important component of any society and government if they want to become spatially enabled. In relation to that, the aim of the current publication is to analyse the possibilities for implementation of the results from flood risk assessment in spatial planning aiming at reduction of flood risk and achievement of sustainable development of the territory. In addition to this, we aim at analyzing to what extent the concept for flood risk reduction should be integrated in spatial development programmes at all levels of government in Republic of Bulgaria.

2. Flood risk assessment – theoretical approach

Disaster risk assessment process involves four steps: (1) hazard characterization; (2) consequence (risk) analysis; (3) risk estimation; and (4) risk evaluation (Risk Assessment, 2010).

Hazard characterisation. Hazard characterization of the planning area is the foundation upon which disaster-risk-sensitive land use planning efforts are built. It provides an understanding of the potential threats which are facing the planning unit. By pointing the location, extent and magnitude of past disaster events, it is possible to determine the probability of occurrence of risk events. Basically, this step answers the questions:

- What types of hazard can affect your planning area?
- How often do the hazards occur?
- Where have these hazards occurred in the past?
- How many human lives were lost?
- How much damage to property is reported?

Risk analysis involves understanding who and what can be affected by a hazard event. Risk analysis is more concrete and small scale instrument than the hazard characterization. In the risk equation, consequence analysis is the product of the exposed elements, namely population and property, and their vulnerability for loss and damage. Given the probabilistic nature of hazards, consequences in terms of number of deaths and property damage are computed based on *factor for fatality* and *factor for property damage*. These factors essentially seggregate that portion of population and properties which would be potentially affected by the hazard, given their vulnerability.

The risk estimation stage answers the questions: How will the planning unit's properties or assets be affected by a hazard event? How many lives will be lost when a hazard event happens?

Risk evaluation is implemented at that stage when decision makers have to deal with the acceptable or not acceptable levels of risk. Generally, it is a rather political process that would involve determining or setting benchmarks for acceptance of certain levels of risk. Conceptually, the As Low as Reasonably Practicable (ALARP) principle is generally used as a guide, i.e., high risks are generally not acceptable while negligible risks are generally acceptable. But there is a certain level of risk between these two extremes that are tolerated on the basis that risks are kept as low as reasonably practicable using benefit and cost analysis (RCC Guideline, 2011).

When it comes to the loss of human lives, zero deaths shall be set as a policy which implies that any levels of risk in terms of fatality would not be acceptable. It is important for policy makers to understand the implications of this policy. For instance, the need for pre-emptive evacuation might require, among others, additional resources in terms of providing for the requirements of the evacuees (such as food, water, medicine, etc).

3. Sustainable spatial planning – theoretical approach

Spatial planning is concerned with "the problem of coordination or integration of the spatial dimension of sectoral policies through a territorially-based strategy" (Cullingworth and Nadin, 2006). More complex than simple land use regulation, it addresses the tensions and contradictions among sectoral policies, for example, for conflicts between economic development, environmental and social cohesion policies. The key role of spatial planning is to promote a more rational arrangement of activities and to reconcile competing policy goals. The scope of spatial planning differs greatly from one country to another, but most share a number of similarities. In almost all countries, spatial planning is concerned with identifying long- or medium-term objectives and strategies for territories, dealing with land use and physical development as a distinct sector of government activity. Spatial planning plays a crucial role in the coordination of the sectoral policies such as transport, agriculture and environment (Koresawa and Konvitz, 2001). It includes activities related to localization, projecting, scaling and harmonization of the space (land) for multifunctional aims (Albrechts, 2006). These activities are implemented by the governing authorities at different levels – national, regional, local level authorities. In this sense, spatial planning is increasingly regarded as one important instrument for disaster risk reduction. Its attractiveness lies in its function for regulating long term use of space on the basis of sound disaster analysis, management and awareness. Through appropriate land use allocation, exposures to natural hazards at the current and future situation can be minimized or sometimes even prevented.

Spatial planning is responsible for the decision on long term utilization of land. Although not directly responsible for disaster risk reduction, spatial planning has fundamental role in disaster risk reduction. The four possible roles of spatial planning in disaster risk reduction, as identified by Fleischhauer *et al.* (2005) are:

- Prohibiting future development in certain areas. In highly prone areas, especially with history of disaster occurrences, development should be prohibited. Areas which are required for emergency response and retention needs should be kept free of new development;
- Classification of different land use setting for disaster prone areas. Every disaster has its own acceptable risk on different land use classes. Steep slope which is highly susceptible to landslide should not be used for residential or commercial area, but may still be suitable for plantation and agricultural areas;
- Regulating land use or zoning plans with legally binding status. For instance, in an area which is vulnerable to earthquakes, regulation on building density is essential to reduce impact of building collapse;
- Hazard modification. Spatial planning can play role in promoting soft engineering methods for reduction of flood risk. For instance, retarding and retention basins which are required to contain water during floods should be kept free of development to maintain its function.

4. Application of the information on flood risk in territorial planning / land use planning

The results from the flood risk assessment form the basis of good understanding of the consequences from the present and future land use management and territorial development. The flood risk assessment provides information about which parts of a certain planning region are endangered by floods; where the losses and damage are most significant; what exactly the damage will be; and how would life and the quality of life in the planning region be affected by the flood. When it comes to land use, the answers to the following questions determine what exact changes are necessary in the current land use of the examined territory:

- Is the current development strategy appropriate? For instance, should construction of residential buildings in the region continue? If not, should their flood resistance be improved?
- Should construction of residential buildings be prohibited in the whole region?

- What will be the negative impact of flood risk on social-economic conditions in the region?
- What are the alternative strategies for territorial development? How do the physical changes affect other regions (for instance, the neighbouring towns, municipalities, provinces, regions) – physically and economically?

The analysis of the negative impact from floods on land use leads planning authorities and decision-makers when determining where and what development should be improved in their settlements or regions, and what special developments should be planned which also reduce the flood risk for the population and property in the region. In relation to this, a very important question is the vulnerability assessment which is related to the existing mechanisms for copying with the negative consequences. Vulnerability reduction ultimately leads to a reduction of the flood risk. Disaster risk reduction is a systematic effort to reduce risks of disasters through the reduction of the risk exposure of the elements in risk and hazard; decreased vulnerability of people and their property; better land management practices and improvement in the preparedness in the region (UNISDR, 2009).

Disaster management process is closely related to spatial development and planning processes. Mainstreaming disaster risk reduction and integrating it into the spatial development programmes and spatial planning at all levels of government is essential. At the national context, mainstreaming can be realized when all related government agencies at all levels become concerned and involved in the development of framework at the same time (Mitchell, 2003).

5. Spatial planning system and flood risk management in Bulgaria

5.1. Governmental structure of R. Bulgaria in brief

Republic of Bulgaria is a central governmental country with three territorial levels of government – national, regional (districts) and local (municipalities). The executive governance is implemented by the Ministerial Council comprising of the ministers and the Prime-minister of the country. Expert groups are established to assist the work of the Ministerial Council. There are 16 ministries in Bulgaria: Ministry of Regional Development and Public Works; Ministry of Labour and Social Policy; Ministry of Foreign Affairs; Ministry of Education and Science; Ministry of Defence; Ministry of Finance; Ministry of Interior; Ministry of Justice; Ministry of Health; Ministry of Agriculture and Food; Ministry of Transport, Information Technology and Communications; Ministry of Economy, Energy and Tourism; Ministry of Environment and Water; Ministry of Culture, Ministry of Youth and Sport; Ministry of Investment Projects.

The main administrative units below the national level are the 28 administrative districts and the 264 municipalities, which have governing functions. After the acception of the Bulgarian membership in the European Union, other levels were introduced between the national and local in order to accomplish the statistical requirements of the European Union. According to the European statistical territorial system, the territory of Bulgaria is divided by six levels. The whole national territory applies to NUTS 0 level. The NUTS 2 regions are important units since they represent the main 6 regions for development of the country (BG 31, BG 32, BG 33, BG 34, BG 41, BG 42). Between the NUTS 0 and the NUTS 2 level, there is NUTS 1 level which corresponds to the regions for development, grouped in 2 main regions - North and South-East Bulgaria (BG 1) and South-West and South-Central (BG 2). NUTS 3 statistical regions are the 28 administrative regions in Bulgaria. There are also two LAU statistical levels – LAU 1 –

corresponding to the 264 municipalities and LAU 2 – corresponding to the 5329 settlements (Fig. 1).

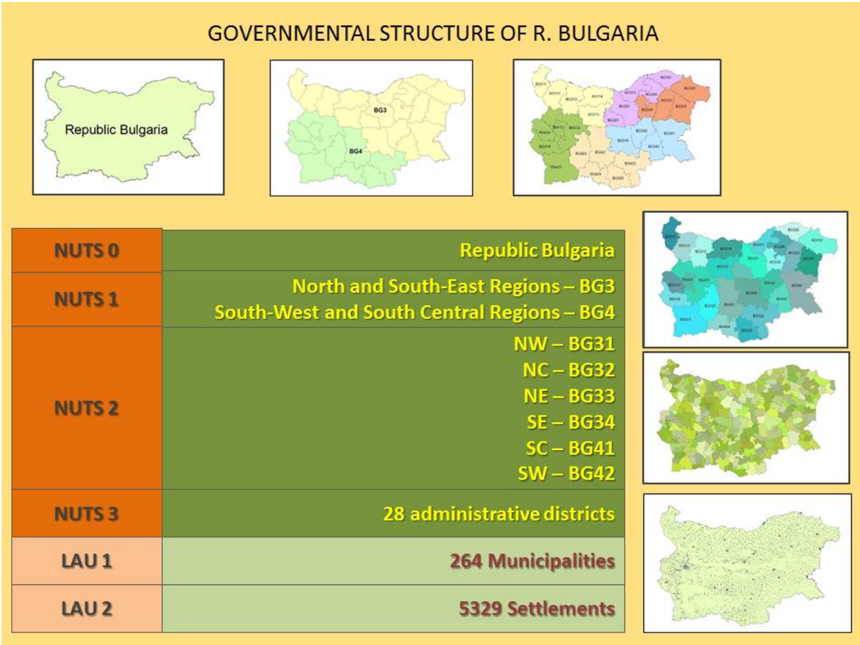

Figure 1. Administrative governmental structure of R. Bulgaria by 2014.

5.2. National Spatial Development Concept

The Bulgarian spatial development model is based on the European Territorial Agenda 2020 (TA 2020). The spatial development in the Bulgaria is framed by the National Spatial Development Concept for the period 2013–2025. The document is based on the TA 2020, developing the ideas of the Lisbon Strategy 2000 and the Göteborg Strategy 2001. The Bulgarian spatial development policy targets the poly-centric and balanced development of the settlements, sustainable development, adaption to the climate changes challenges, etc. The essence and the content of the Concept is definitely influenced by the national aims of protection from the natural hazards and risks, incl. flood risk. The principles of flood risk management are considered during the formation of the Concept's direction and priorities. The National Concept defines territories with specific characteristics to which special policies shall be applied - development planning, technical development policies, etc. Such territories include: coastal areas (Black sea and the Danube), mountain regions, territories at risk (demographic, economic and ecological). The territories which are exposed to natural risk are not directly included as specific areas, but indirectly they match all the upper listed specific areas. Nevertheless, the national document does not specifically and directly distinguish areas at natural risk as specific areas for development where certain regulations should be introduced. Flood risk management though could be included in several of the Concept's approaches, related to improvement of the settlements' infrastructure and transport infrastructure; sustainable urban development; protection and preservation of the natural and cultural heritage, territorial planning in compliance with the hazards and challenges of the demographic and climate problems, etc.

The Concept should have primary importance in determination of the territorial planning in relation to reduction of flood risk as it "... determines the state policy in territorial planning ..." and defines the purposes of the "... strategies for integrated spatial development, taking into account the territorial potential and the principles of the balanced sustainable development" (Art. 7a (1) Spatial Planning Act). An important role of the Concept is the definition of zones with specific use with regional and national importance and where specific policies shall be developed. Such areas could and shall be, for instance, flood risk zones, retention basins and others.

Nevertheless, the risk of natural hazards and risks have significant impact on the spatial planning approaches. The National Spatial Development Concept takes into consideration the significance of the spatial planning approaches and their role in the flood risk management policies and climate change mitigation. The document defines floods as one of the major natural risk for the territory of R. Bulgaria. Furthermore, the document points out the areas with higher risk for development in Bulgaria – the Danube River coast, the Black sea coast and the river coasts. The recovery of the territories, affected by natural disasters, adaption and risk reduction are addressed by Priority 5 "Enhanced development of the specific territories" of the National Concept.

5.3. National Strategy for Regional Development

The strategic framework of the Bulgarian national policy for balanced and sustainable development is drawn by the National Strategy for Regional Development for the period 2012–2022. The National Strategy for Regional Development and the related spatial planning documents are elaborated in compliance to the *Methodological Guidelines for development of National Strategy for Regional Development (2012–2020), Regional Development Plans - NUTS 2 (2014–2020), Regional Development Strategies – Districts (2014–2020) and Local Development Plans (2014–2020).* The document sets the contents and policies direction. In addition to this, the Methodology defines the main indicators for regional development, among which environmental indicators for risk prevention and management - number of protected population. The Bulgarian spatial development for the new programme period of the EU follows the principles of the European development – territorial cohesion, executed by the principles of subsidiarity and proportionality. The risk prevention and adaptation are priorities of the European development and a tool for sustainable development of the regions - one of the main principles for regional development.

The National Strategy for Regional Development sets the direction for the elaboration of the Operative Programme Regional Development and the spatial development documents at different levels - regional and local (Fig. 2). The different levels of strategic planning policy are developed by the main governing structures. The National Concept for Spatial Development 2013 - 2025, the National Strategy for Regional Development 2012–2022 and the Regional Development Plans 2014–2020 are elaborated on a national level by the national authorities. The Regional Development Strategies are elaborated and implemented by the regional authorities – districts. The Local Development Plans 2014–2020 and the Plans for Integrated Urban Development 2014–2020 are developed and implemented at a local level by the local governing authorities – municipalities (Fig. 2).

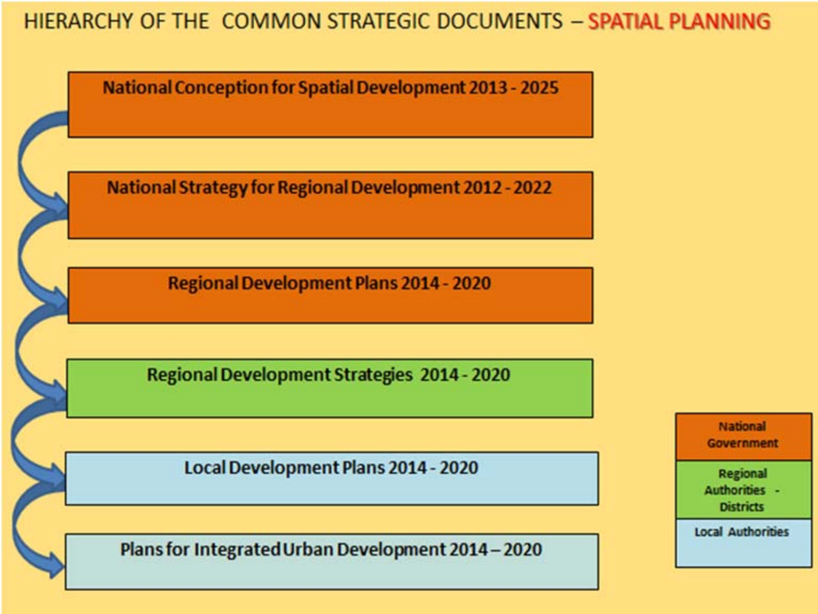

Figure 2. Common strategic documents for spatial planning in Bulgaria.

The prevention of natural risks is defined in Specific aim 5 – Prevention of Natural Risks of the National Strategy for Regional Development. The activities related to the aim address the building of an early warning system for natural hazards, among which floods and others, cleaning of the river beds, development of defence structures. Apart from that, certain development approaches and priorities are closely related to the reduction and adaption of the natural risks, incl. flood risk. The Strategy addresses the need to combat negative effects of climate change, adaptation and management. Increased flood risk is one of the negative effects of climate change and therefore the aim addresses flood risk management indirectly though climate change adaption. The Bulgarian spatial development policy addresses certain demographic problems, among which the increase of the concentration of population (centric urban development). This development tendency has a strong relation to the flood risk management because the concentration of the population is most often in coastal and tidal areas with high flood risk. A serious demographic problem is the aging of the population and depopulation in the rural areas, which is a significant problem in flood risk management, especially the phases of reaction and recovery.

5.4 Challenges of the future sustainable territorial development

However, the guidance for elaboration of the Bulgarian development strategies and plans on regional and local level does not clearly and definitely state the need for integration of the flood risk management and regional development policies. This is a prerequisite for the existence of serious gaps in the spatial development documents regarding flood risk management. Flood risk is a serious obstacle for the Bulgarian territorial development. Therefore, the challenges of the future sustainable territorial development include the closer integration of the flood risk management instruments, especially the use of the flood risk maps being relatively detailed plans for territorial development. For the purposes of the sustainable territorial planning and management, flood risk management should be integrated in the spatial development documents from as early stage as possible. The national, regional and local development documents should include measures for reduction of the existing and potential flood risk as a tool for the sustainable territorial development.

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Chronicle of European seminars of water geography 2005–2014

Photos: Edgar Sepp and Antti Roose

9th European Seminar on the Geography of Water Integrated water management of small river basins. River basin management planning in South-Estonia

18.08. – 28.08.2005, Tartu, Estonia

Seminar programme

18.08.2005, Thursday, Arrival		
19.08.2005, Friday		
09:30	Lectures to the main problems of environmental protection and water management in Estonia. Lectures by Tiiu Koff, Anto Raukas, Ain Lääne, Maret Merisaar, Karin Pachel, Peeter Marksoo	Tallinn, Jägala
15:00	Excursion: water supply system: Lake Ülemiste, Vaskjala regulating facilities; Jägala waterfall; Linnaküla HPP	
20.08.2005, Saturday		
08:00	Technical excursion in West-Estonia: Paldiski town (previous Russian military centre) and limestone cliff, resort town Haapsalu	Paldiski, Haapsalu
14:30	Visiting of Ridala church (Kari Tünkkünen)	Ridala
16:30	Workshop in Matsalu: Use and rehabilitation of seminatural biotopes: case studies of Matsalu wetland, Kasari floodplain and coastal meadows	Matsalu
21.08.2005, Sunday		
09:00	Excursion in Southwestern Estonia: Sindi dam on the Pärnu River, Soomaa national park – bog landscapes and building of log-boats	Pärnu, Sindi, Soomaa
15:00	Workshop in the Võrtsjärv Limnological station: Influence of human impact and climate change on the ecological state of shallow lakes Lectures from Arvo Tuvikene, Ain Järvalt, Lea Tuvikene, Arvo Järvet	Võrtsjärv
22.08.2005, Monday		
09:00	Opening of seminar at the university main building and excursion	
10:15	Defence of doctoral dissertation of Antti Roose "Optimisation of environmental monitoring network by integrated modelling strategy with geographic information system — an Estonian case"	
12:00	Urmas Peterson, Changes in land use of Estonia estimated with remotely sensed data	Tartu
14:00	Tõnu Oja, Environmental Impact Assessment in Tartu masterplan	
16:00	Excursion in Tartu: Waste-water treatment plant, Emajõgi River, Emajõgi Barge-yard	

23.08.2005, Tuesday		
09:00	Ülo Mander, Use of bufferzones and bufferstripes in water protection of agricultural areas	Tartu
10:00	Presentations and discussion of water related studies in participating universities	
14:00	Field trips to working group case study locations Õhne, Tänassilma and Amme rivers. Working group sessions. Presentations from local stakeholders and visits to Tõrva town hall, Taagepera village and manor, Vooremaa Nature reserve, Tänassilma natural wetland	Valga, Tõrva, Vooremaa
24.08.2005, Wednesday		
09:00	Field works at river basins of working groups: Õhne, Tänassilma and Amme rivers. Presentations from local stakeholders and field visits to Rubina Landscape Reserve, Hellenurme Water mill, Beaver dams at Õhne river, EKSEKO Pig Farm, Waste-water treatment plant of Viljandi	Valga, Tõrva, Hellenurme Vooremaa
25.08.2005, Thursday		
09:00	Külli Kangur, Long-term trends in ecological state of lake Peipsi Kati Kangur, Facilitating transboundary management of Lake Peipsi and its basin: experiences of Peipsi Centre for Transboundary Cooperation	Tartu
11:00	Preparation of the working groups presentations: analysis of materials, measurements and information, discussion, summarization	
14:00	Excursion in Lake Peipsi coastal area	Lake Peipsi
26.08.2005, Friday		
10:00	Rivo Noorkõiv, Regional policy in Estonia – case strategic questions	Tartu
11:15	Preparation of the working groups presentations	
14:00	Visiting the Estonian national museum, Helen Sooväli – Estonian landscapes in change: representations and realities	
27.08.2005, Saturday		
09:30	Jüri Roosaare, e-Learning in Estonia –problems and challenges for hydrology	Tartu
11:00	Presentations of Working Groups	
13:30	Excursion in South-east Estonia: Taevaskoja valley (Devonian sandstones), Haanja Height and Rõuge lakes	Taevaskoja, Rõuge, Haanja
18:00	Cultural programme, sport and sauna	Koke
21:00	Official conclusions and closing ceremony of the seminar	
27.08.2005, Sunday, Departure		

Participants

University of Cagliari, Italy
- Andrea Corsale
- Monica Iorio

Johannes Gutenberg University Mainz, Germany
- Volker Heidt
- Brigitte Leicht
- Andreas Szöcs
- Axel Sauer
- Jörg Steinkamp
- Eva Hochhut

University of Padua, Italy
- Massimo de Marchi
- Silvia Piovan
- Andrea Ninfo
- Elisa Vanzo
- Grazia Zulian
- Sara Ariano
- Nadia Carestiato

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- Levente Ronczyk
- Amade Halasz

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- Jan Kocum
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- Larissa Titolo
- Melissa Maserotti

University of Tartu, Estonia
- Arvo Järvet, academic chair
- Antti Roose
- Martin Madisson
- Henn Pärnamets
- Reimo Alas

Working group topics

Amme River Basin

Catchment area 501 km^2; 13 lakes with total area 20 km^2, the Saadjärve Drumlin Field.
Scope: Optimisation of agricultural landscape, lake protection and river restoration.
Renaturalisation of small running waterbodies in artificial channel.
Water policy issues:

- Changes of historical semi-natural landscapes.
- Beaver dams and damages in the river bank zone.
- Agricultural use of drumlins: small sized farms; Soviet collectivization and reprivatization; abandoned fields and farms; natural floodplain.

Tänassilma River Basin

Catchment area 453 km^2, affecting the Lake Võrtsjärv (270 km^2, mean depth only 2.8 m).
Scope: Municipal waste-water treatment and use of the wetlands for water protection, agricultural land use; wetlands as natural filters and buffer zones.
Water policy issues:

- Pollution reduction of EKSEKO pig-farm (slurry production 117 000 m^3 per year)
- Waste-water treatment upgrading in Viljandi (21 000 inhabitants)
- Use the wetlands for reduction of diffused pollution from arable land
- Developing the historical Hanseatic waterway for water tourism.

Õhne River Basin

Catchment area 573 km^2, inflow of Lake Võrtsjärv; heritage rural area; Rubina landscape reserve; Tõrva town (about 3 000 inhabitants); Taagepera manor
Scope: Integration of nature protection, non-intensive agriculture and tourism.
Water policy issues:

- Developing the new wastewater treatment plant in town Tõrva
- Eutrophication processes
- Potential of joint trans-boundary policies and activities with Latvia
- The Õhne river for a touristic route and promotion of sustainable rural tourism

Erasmus scholars in front of the University of Tartu main building (22.08.2005).


Defence of doctoral dissertation of Antti Roose (22.08.2005).

Field trip to Kuresoo bog at the Soomaa National Park (21.08.2005).

The 'Eurovision of water geography' song contest in the farewell evening in Koke, Haanja upland. *Johannes Gutenberg-Universität Mainz* represents Germany, frontmen with accordion, project coordinator Prof. Dr. Volker Heidt. (27.08.2005).

10th European Seminar on the Geography of Water Water Management in the South of Spain: Managing Drought and Water Scarcity in Vulnerable Environments

26.06. – 06.07.2006, Sevilla, Spain

Seminar programme

25.06.2006, Sunday, Arrival	
26.06.2006, Monday	
Opening session by prof. Juan Luis Suarez Participant Universities' presentations, Poster session Field work: recent urban transformation and the reallocation of the Guadalquivir River in Seville	Sevilla
27.06.2006, Tuesday	
Lectures: - Yopics presentation by prof Leandro del Moral - Regional geographical context by prof Monica Aguilar - Drought management by Luis Babiano - Agricultural uses by prof. Pepe Miranda, Consuelo Giansante Poster sessions	Sevilla
28.06.2006, Wednesday	
Lectures: - Water framework directive by prof. Leandro del Moral - Impacts and damages of water bodies by prof. Pascual Riesco Visit to the Guadalquivir River Basin Authority Working group session	Sevilla
29.06.2006, Thursday	
Field trip to the west coast – Donana, coordinated by Victor Garcia; Ana Villa and Ismael Vallejo	Doñana National Park
30.06.2006, Friday	
Case study – Guadiamar river restoration, coordinated by Rafa Baena, Inmaculada Guerrero, Belen Garcia	Guadiamar river

01.07.2006, Saturday		
	Field trip to rural areas – Ronda	Ronda
02.07.2006, Sunday		
	Field trip to rural areas – Cuevas del Becerro	Cuevas del Becerro
03.07.2006, Monday		
	Field work: - Drought management – EMASESA - River restoration – Guadaira case study - Agricultural uses, CAP - WFD, CENTA Working group session	Sevilla, Alcalá de Guadaira
04.07.2006, Tuesday		
	Visit to the Seville's port Working group sessions	Sevilla
05.07.2006, Wednesday		
	Presentations of Working group sessions Official conclusion of the IP Dinner and cultural program	Sevilla, Almensilla
06.07.2006, Thursday, Departure		

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Cristina Sivieri

University of Pecs, Hungary
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Levente Ronczyk
Janos Csapo
Amade Halasz
Tibor Pecz

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Milada Matouskova
Dagmar Chalupova
Sylva Rodlova
Vaclav Sipek

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Lyubomir Filipov
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University Jean Monnet, Saint Etienne, France
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Yohann Benmalek
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Jüri Roosaare
Arvo Järvet
Edgar Sepp
Eva Liivak

University of Udine, Italy
Franca Battigelli
Andrea Guaran
Luigina di Giusto
Meri Mauri

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Veronica Montilla
Arsenio Villar
Miguel Garcia
David Sampedro
Antonio Ramirez

Working group topics

Drought management

New concepts and experiences on drought management were debated. Drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector. Disciplinary Perspectives on Drought are as follows: meteorological, hydrological, agricultural and socioeconomic. Following case studies were discussed: the National Drought Observatory; EMASESA (Seville urban water company) drought management plan aiming to control the integral water cycle, to manage and prevent future drought situation (handbook titled as “manual de Sequía” which uses GIS apporach).

River restoration

Using case studies impacts and damages of water bodies and its influence on associated ecosystems were discussed. First case study includes Guadiamar river and the changing aspects along the river such as olive production and related sewage water. Second case study analyses the catastrophy of mining residual tank in Aznalcollar and its effects on Guadaira river. Topics of discussion included: green corridor for biodiversity, conservation, wildlife moving, restoring ecosystem, preventing genetic regeneration, buying private lands, educational and public usage, tourism.

Agricultural uses

This topic was about new trends in agricultural water uses. Irrigation as the main water demand sector in Mediterranean Countries. Main discussion points were: modernization of irrigation schemes; water reallocation experiences; impacts of the European Agricultural policies. Case studies: agriculture in the Coast of Huelva (Doñana) and Malaga provinces (Ronda area).

Water Framework Directive

The European Commission has developed a Common Implementation Strategy (CIS) establishing a framework for Community action in the field of water policy (the Water Framework Directive – WFD 2000/60/EC). The purpose of this strategy is to ensure a coherent and consistent implementation of the Directive throughout the member and pre-accession countries. The major principles of WFD are public participation, polluter pays principle, precautionary principle, and controlling and monitoring. Case studies: the Guadalquivir River Basin Authority; CENTA (Regional Water Institute)

Erasmus scholars at *la Finca Algaba de Ronda.C*ase of agricultural water uses (02.07.2006).

Lecturers and students discussing at the poster session (26.06.2006).

The survey to the active dunes at the Doñana National Park, guided by Ismael Vallejo (29.06.2006).

Cultural programme in a wine cellar and restaurant *La Sacristía* (05.07.2006).

11th European Seminar on the Geography of Water
Water Security Problems in Bulgaria

29.06. – 10.07.2008, Sofia, Bulgaria

Seminar programme

29.06.2008, Sunday, Arrival		
30.06.2008, Monday		
10:00	Official opening at Sofia University AULA: Ceremony speech of the Dean of Faculty, Antti Roose, Prof. Petar Slaveikov, D. Zlatunova	
11:20	Assist. Prof. B. Borisova, Bulgarian Nature Potential Assoc. prof. D. Zlatunova, Environmental and Human Security – Conceptual and theoretical issues. The Water as a security element	
15:30	Assoc. Prof. N. Hristova, Water in the world: Where is it? How much is there of it? Whose is it? Assoc. Prof. Alexandrov, Agricultural dimensions of water security Assoc. Prof. N. Hristova, Bulgarian wetlands and the Water security problems	Sofia
19:00	Walk trip to Sofia city Center	
01.07.2008, Tuesday		
09:00	Case study: Iskar Dum	Iskar Dum
11:00	Case study: Bistriza Drinking Water Treatment Plant	Bistriza
15:00	Case study: Kubratovo Sewage Water Treatment Plant and Sovage Hydro Power Plant	Kubratovo, Sovage
02.07.2008, Wednesday		
10:00	Plovdiv old city	Plovdiv
12:00	Chudnite mostove – The Wonder Bridges	Plovdiv
15:30	Assoc. Prof. N. Nikolova, Air temperatures and Precipitation Variability in Bulgaria in the context of Climate Change – Causes and Consequences Assoc. Prof. I. Penkov, Boundary rivers – main security problems	Pamporovo
17:00	Compilation of Working groups	
03.07.2008, Thursday		
08:00	Assist. Prof. K. Naidenov and prof. P. Slaveikov, Demographic situation and water use – Bulgarian case	
11:00	Case study: Pamporovo ski resort – water problem of Pamporovo ski resort Assist. Prof. K Stoychev, “Hydroenergetics in Bulgaria: current situation and future alternatives”	Pamporovo

14:30	Case study: Smolianski ezera – Smolianski lakes	Smolian
16:00	Case study: Smolian water – Regional Inspection on environmental and Water /RIEW/ Smolian.	
18:00	Walk trip to Smolian	
04.07.2008, Friday		
08:00	Trip and case study to Trigrad and cave Djavolskoto garlo	Trigrad
14:00	Presentations of the guest professors	Pamporovo
15:30	Poster session of students	
16:30	Working group session	
05.07.2008, Saturday		
10:30	Case study of Arda river, recultivation of the depository, Environmental centre in Madjarovo	Madjarovo
18:00	Accommodation in Bourgas and Working group session	Bourgas
06.07.2008, Sunday		
08:30	Case study: RIEW Bourgas	Bourgas
10:30	Case study: Bourgaski lakes – „Poda“ wetland	
12:30	Working group session	Sozopol
07.07.2008, Monday		
08:40	Case study Pomorie wetland	Pomorie
12:00	Lecture in The Bulgarian Academy of Sciences – Case study: Black sea and Costal zone	Varna
19:00	Floating ship restaurant „Balkan Princess“	Ruse
20:30	Working group sesion	
08.07.2008, Tuesday		
09:30	Case study Danube River – Executive agency „Researches and maintenance of The Danube River“	Ruse
14:10	Walk trip to Veliko Tarnovo	Veliko Tarnovo
19:30	Working group session	Sofia
09.07.2008, Wednesday		
10:00	Presentation of the Working group results	Sofia
19:00	Official dinner in the Restaurant – Sofia University	
10.07.2008, Thursday, Departure		

Participants

University of Cagliari, Italy
- Andrea Corsale
- Monica Casu
- Michele Carboni
- Raffaella Salis

University of Padua, Italy
- Massimo De Marchi
- Naddalena Natalicchio
- Anna Brusarosco
- Evarossella Biolo
- Sonia Ziliotto

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- Zoltan Wilhelm
- Levente Ronczyk
- Bertalan Radvánszky
- János Csapó

Charles University in Prague, Czech Republic
- Dagmar Chalupova
- Vaclav Sipek
- Martin Dvořák

University Jean Monnet, Saint Etienne, France
- Sylvain Lecki

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- Antti Roose
- Jüri Roosare
- Edgar Sepp
- Merle Looring
- Rain Elken

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- Franca Baticelli
- Andrea Guaran
- Alberto Cancian
- Francesca Coden
- Sergio Cecchini

University of Sevilla, Spain
- Belen Bedregal Mateos
- Pilar Díaz Cuevas
- Bilal Paladini San Martín
- Ana Louise Trout Tate
- Andrea de Oliveira Nascimento

Sofia University St. Kliment Ohridski, Bulgaria
- Petar Slaveikov
- Daniela Zlatunova, academic chair
- Nelly Hristova
- Bilana Borisova
- Nina Nikolova
- Kosyo Stoychev

Working group topics

Water in the World: Where is it? How much is there of it? Whose is it?

Freshwater is unevenly distributed geographically and temporally, resulting in surpluses for some regions and a threat of severe water insecurity for others. Over 70% of our Earth's surface is covered by water. 97.5% of all water on Earth is salt water, leaving only 2.5% as fresh water; nearly 70% out of that fresh water is frozen in the icecaps of Antarctica and Greenland; most of the remainder is present as soil moisture, or lies in deep underground aquifers as groundwater not accessible for human use. Less than 1% of the World's fresh water is accessible for direct human uses. This is the water circulating in lakes, rivers, reservoirs and those underground sources that are shallow enough to be tapped at an affordable cost. Only this amount is regularly renewed by rain and snowfall, and is therefore available on a sustainable basis.

Dimensions of water security

Many of the factors relevant for human wellbeing and development are directly or indirectly linked to freshwater resources. The intersection of these factors show that the significance of water scarcity is even multiplied by these interdependent evolutions and that the depletion and degradation of the resource has therefore far-reaching consequences. We distinguish here between different dimensions such as the demographic and the urban, the sanitary, the agricultural and the climatic one. Using Bulgarian examples of how freshwater resources already have an important impact on human development and how such a categorization can help to the understanding of structural roots of antagonistic interests related to water security.

Bulgarian Costal zone and Water Security Problems

The specifications of the contact zone "sea-mainland" were elaborated, the wetlands connected to these zone and the river basins flowing into the Black sea. High intensity of the anthropogenetic pressure caused by the tourist industry is causing many water security problems that were observed and discussed.

International Rivers and Water Security Problems – case study of Danube River

As human populations and economies grow exponentially, the amount of freshwater in the world remains roughly the same as it has been throughout history. While the total quantity of water in the world is immense, the vast majority is either saltwater (97.5%) or locked up in ice caps (1.75%). The amount of water economically available for human use is only 0.007% of the total, or about 13 500 km^3. This comes out to only about 2300 m^3 per capita – a 37% drop since 1970. Adding complexity to this increasing scarcity is the fact that almost half the globe's land surface lies within international watersheds. These lectures presented the global water crisis, conflicts and and resulting political tensions.

Erasmus scholars on board of the ship “Balkan Princess” on the Danube River in Ruse. Case of cross-border water policy and management (08.07.2008).

Due to bus failure working group session was held in the bus on the way back to Sofia (08.07.2008).

Field trip to Sovage hydro power plant, surveying fish ladder (01.07.2008).

Case study of the mining depository recultivation downstream Arda River in Madjarovo (05.07.2008).

12th European Seminar on the Geography of Water Water Resources, Management and Security in Southern Europe

28.06. – 09.07.2009, Udine, Italy

Seminar programme

28.06.2009, Sunday, Arrival		
29.06.2009, Monday		
09:15	Opening ceremony, Welcome addresses Presentation of the Seminar, F. Battigelli, University of Udine	
11:00	Water security and conflicts: an introduction, A. Massarutto, University of Udine	
15:30	Water resources in the Mediterranean Basin, F. Battigelli Water in Cyprus: issues and problems, D. Lombardi	Udine
17:30	The Tagliamento river, a reference system of European importance, N. Toniutti, WWF Italia Natural areas in the upper basin of Tagliamento river, R. Zorza	
30.06.2009, Tuesday		
09:00	Tourism and water security in Sardinia, M. Iorio, A. Corsale, University of Cagliari Water issues and security in Friuli Venezia Giulia, M. Ret, Regional Riverbasin Authority	
11:30	Working group session	Udine
15:45	The Lagoon of Marano-Grado, G. Mattassi, FVG Upper Adriatic Observatory	
17:30	Guided tour of the city of Udine	
01.07.2009, Wednesday		
07:15	Field Trip: The lower Tagliamento river and the Lagoon of Marano - Morning: The seaside resort of Lignano Sabbiadoro. The marina of Aprilia Marittima. Latisana, Townhall: coping with flood risk. - Afternoon: Marano: the eco-system of the lagoon. Uses and conflicts: the viewpoint of stakeholders.	Lignano Sabbiadoro, Marano, Latisana
02.07.2009, Thursday		
09:00	Karst landscapes and geosystem in Northeastern Italy, U. Sauro, University of Padova The “ Classical Karst”, F. Cucchi, University of Trieste Karst in Northern Europe, A.Jarvet, University of Tartu	Udine

15:30	Working group session, methodological introduction: - Tagliamento River group, S. Ariano and S. Cecchini - Lagoon of Marano group, N. Carestiato - Karst group, L. Visintin	Udine
17:30	Poster session	
03.07.2009, Friday		
08:00	Field Trip: Upper and mid River Basin of Tagliamento - The river ecosystem and landscape. - Water uptakes. - The hydro-power plant of Somplago. - Projects for preventing river floods: the viewpoint of stakeholders.	Pinzano al Tagliamento, Somplago
04.07.2009, Saturday		
07:30	Field Trip: The Classical Karst - S. Giovanni di Duino: Karstic springs of the Timavo river. - The Rilke Path: Karstic morphology and landscape. - The Karst in Slovenia: the Skocjanske Jame and the Reka river.	Duino, Škocjan
05.07.2009, Sunday		
09:00	Field Trip: The Lagoon of Grado	
06.07.2009, Monday		
08:30	Field Trip: The earthquake area; water supply plants - The medieval town of Gemona: post-earthquake reconstruction. - The Central Friuli Water Supply Company.	Gemona
15:30	Presentation of Universities' Research on Water - Water issues in Romania, Z. Pal, University of Cluj Napoca - GIS tools and projects in Friuli Venezia Giulia, S. Amaduzzi, University of Udine	Udine
17:15	Working group session	
19:30	Farewell Dinner - Restaurant "Al Zuc" – Pagnacco	
07.07.2009, Tuesday		
09:30	Water as a human right, R. Cavallo, Ce.V.I. NGO, Udine	
11:00	Poster session	Udine
15:30	Working group session	
08.07.2009, Wednesday		
09:00	General session: Reports from the Working groups 1, 2 and 3	
11:30	Evaluation of the Seminar and Certification ceremony	Udine
16:00	Conclusions and follow up. End of the IP	
09.07.2009, Thursday, Departure		

Participants

University of Cagliari, Italy
- Andrea Corsale
- Monica Iorio
- Monica Casu
- Francesca Fois

University of Pecs, Hungary
- István Fodor
- Krisztina Babák
- Noémi Lívia Görcs
- István Péter Kovács

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- Daniela Zlatunova
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- Zoltan Pal
- Apollónia Bece
- Boglárka Czellecz
- Alpár Miklós

Charles University in Prague, Czech Republic
- Bohumir Jansky
- Milada Matouskova
- Dagmar Chalupova
- Václav Sípek
- Kateřina Šmerousová

University of Udine, Italy
- Franca Battigelli, academic chair
- Andrea Guaran
- Sara Ariano
- Nadia Carestiato
- Sergio Checcini
- Luca Visintin

Working group topics

Water management in a fragile ecosystem: the lagoon of Grado-Marano between land and sea

In the contact belt where land and sea meet, the lagoon of Marano-Grado marks the transition through different physical and human environments: from the humid coastal plain and wetlands, to the lagoon basin to the outer islands and "lido". The fragile lagoon ecosystem largely depends for its survival on a balanced entrainment of water and sediments by rivers, while water is highly needed by human settlements and by the different uses and activities that gather in the area: industry, agriculture, tourism. Although not scarce in quantity, freshwater can therefore be a problem in terms of quality, particularly during the peak demand in summer.

The Tagliamento riverbasin: how to manage a still "natural" river?

The Tagliamento river flows from the Alps to the Adriatic sea, in a still natural hydrological regime: it keeps in its middle course a typical braided gravely riverbed – up to 3 kilometers in width - flanked with belts of fluvial vegetation; but flood risks are frequent and dangerous in the lower course. In order to prevent floods a number of high-impact solutions have been proposed, against which a strong opposition is arising among population and environmental associations. During the seminar, the Tagliamento riverbasin was assessed by different viewpoints: the hydrological and ecological aspect, man-river relations, the economic and productive function (e.g. gravel and sand extraction), flood hazards and projects for prevention, the river landscape.

Water and the Karst in the area of Trieste: karstic morphology, surface and underground water, springwater uses

Water in the karstic plateau of Trieste was analysed under different, but integrated, viewpoints: water as a morphogenetic factor, by which the karstic topography is shaped both in its surface features (karren, dolines, the Rosandra valley) and beneath (caves, such as the big Grotta gigante); underground drainage systems (karst aquifers); karstic water, notably the Timavo river. Water quality and quantity, different uses of springwater (water supply to the town, water and the environment, water as a touristic resource) were investigated.

Erasmus scholars on the bridge over Tagliamento River near Pinzano al Tagliamento. Case of sub-mountainous river basin (03.07.2009).

Field trip on the Lagoon of Gardo with local fishermen (01.07.2009).

Visit to the The Central Friuli Water Supply Company near Gemona (06.07.2009).

Field lecture on karst by prof. Franco Cucchi near Duino (04.07.2009)..

13th European Seminar on the Geography of Water Community Scale Water Management Patterns in Transylvania

04.07. – 15.07.2010, Cluj Napoca, Romania

Seminar programme

04.07.2010, Sunday, Arrival		
05.07.2010, Monday		
09:30	Registration at the Faculty of Geography	
10:30	Opening ceremony: Antti Rose, Zoltán Pál, Dan Petrea, Dean of the Faculty of Geography	
	Administrative presentations, Boglárka Czellecz and Alpár Miklós	Cluj-Napoca
15:15	István Kővári, The groundwater monitoring network in Romania	
16:05	Ene Indermitte, Health risk assessment of fluorides in drinking water	
	Andrea Guaran: Remembering the 12th Seminar	
06.07.2010, Tuesday		
09:30	Elek Péter, The actual issues of the exploitation and consumption of mineral waters in Romania, special cases in Transylvania	
	Quantitative and qualitative water management in Olt river catchment, János Darvas and Agnes Darvas	Cluj-Napoca
	Zoltán Pál: Settlement groundwater contamination with nitrates	
15:00	Participant university student presentations	
07.07.2010, Wednesday		
09:30	What is mineral water by Ferenc Wanek	
11:00	Levente Ronczyk: Mapping Urban Land Cover from Aerial Photos and Parcels Data Using an Object-oriented Approach in Pécs	
	Lecture by Massimo De Marchi, University of Padova, Italy	Cluj-Napoca
	Boglárka Kis: Seklerland's Mineral Water Database	
15:00	Gergő Török: Water related development projects	
16:00	Working group session	
17:30	Historical centre of Cluj. Guided tour by Nóra Vicsai	
08.07.2010, Thursday		
12:30	Mineral water museum at Băile Seiche bath, Szejke-fürdő	Băile Seiche
14:00	Visit to mineral water springs trough bath Chirui, Nádasszék, Selters	bath, Chirui
	- mineral water usage and potential, Czellecz Boglárka	bath, Selters,
	- mineral waters and traditional spa usage, Julianna Mag	Nádasszék,

09.07.2010, Friday		
09:30	Visit to the creek Mădăraş, Madaras-patak – K. Petres Ș. Gheorghe	Madaras
	Visit to the creek Racu, meeting with the major of the commune Racu	
13:00	Working group session	
14:15	The Ciuc basin groundwater patterns, Zoltán Pásztohy	Racu
	Groundwater quality and quantitative patterns, Márta Péter	
	Visit to a traditional rural household and the ballast station	
17:45	Working group session	
10.07.2010, Saturday		
08:30	Visit to the dam of Frumoasa, János Darvas	Csíkszépvíz
11:00	Crater lake Sf. Ana and Mohos Peat Bog, S. Sütő and Zoltán Pál	Lake Sf. Ana
15:00	Former spa Băile Cisar (Csiszárfürdő), natural moffettas, and baths, huge diversity of post volcanic activity and Apor bath, Z. Fekete	Băile Cisar, Apor bath
11.07.2010, Sunday		
08:30	Visit to the Salt canyon, lecture about the risky interaction of Corund river, Korond-patak and the salt diapire. István Horváth	Praid, Parajd
16:15	The effect of the silting phenomenon on the characteristic volumes and the lake basins in Someșul Cald reservoirs cascade system; The Salt lakes from Sovata - Mures County, Șerban Gheorghe	
18:00	Working group session	
12.07.2010, Monday		
08:45	Korond mineral water educational path, Attila Tóth, Imola Andorkó	Korond
14:30	Visit to the Balneological centre of bath Băile Sovata (Szovátafürdő) and famous heliothermal salt lake Ursu (Medve-tó)	Băile Sovata, Lake Ursu
18:30	Working group session	Praid, Parajd
13.07.2010, Tuesday		
09:45	Ecological restoration model of the wetlands and distribution of the nitrate pollution in the Niraj riverbasin, Zoltán Hajdu	Adrianu Mic, Kisadorján
13:30	Meeting with the major of Gálfalva, short visit to the location of wetland (meander)rehabilitaion: a bottom up approach	Gálfalva
19:15	Farewell, presentation of the 14th Seminar of Water, Andrea Corsale	Săvădisla,
14.07.2010, Wednesday		
09:30	Field visits guided by Șerban Gheorghe: reservoirs and underground power plant at Tarnița and drinking water treatment station	Tarnița
14:30	Working group session	Cluj-Napoca
16:00	Final reports on working group topics	
17:45	IP closing ceremony	
15.07.2010, Thursday, Departure		

Participants

University of Cagliari, Italy
- Andrea Corsale
- Michele Carboni
- Marisa Fois
- Laura Pili

University of Pecs, Hungary
- Levente Ronczyk
- Krisztina Babák
- Viktoria Nemes
- Pisztér Gergely

Sofia University St. Kliment Ohridski, Bulgaria
- Panka Babukova
- Violeta Vilieva
- Alexander Penkov
- Georgy Isakiev

University of Tartu, Estonia
- Avro Jarvet
- Antti Roose
- Edgar Sepp
- Ene Indermitte
- Sirle Trestip

University of Sevilla, Spain
- Sergio Segura
- Maria Villarin
- Antonio Trillo
- Rosa Amoros

University of Padua, Italy
- Massimo de Marchi
- Silvia Piovan
- Nicola Destro
- Carlotta Cervesato
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Babeş-Bolyai University, Cluj-Napoca, Romania
- Zoltan Pal, academic chair
- Boglárka Czellecz
- Gheorghe Şerban
- Árpád Szász
- Zsombor Fekete
- Boglarka Kis
- Zombor Fazakas
- Imola Andorko
- Alpar Miklos
- Barna Ban

Working group topics

Water management patterns

Water-related territorial planning and developments at different scales. Territorial and functional differences were emphasized in the field of water management. River-based water supply, high performance sewage treatment plant in Targu Mures (150 000 inhabitants), mountain creek based drinking water supply and deficient sewage treatment program and powerful bathing season in Sovata (20 000 inhabitants and 7 000 tourists daily in the peak season), and the typical Transylvanian village without centralized drinking water supply and no sewage collector network. During field trip local alternative sustainable solutions in the field of water retaining and sewage treatment were presented.

Groundwater contamination in rural areas: phreatic groundwater use and its sanitation consequences in a 2010 EU country

Nitrates in groundwater are continuously acute critical problem in Transylvania. Many rural settlements in Transylvania have drinking water network but lack the sewage system. The quantity of the chemicals used on the fields do not exceed the optimal value, thus the nitrate pollution of the groundwater is caused by communal sources. This fact raises lots of hygienic and health issues in the rural areas. The newly developed drinking water networks are mainly vertebral networks, the water does not enter the households, it is present only along the road network of the settlement. The lectures and working groups were focused on finding the best practices and the optimal solutions for the rural areas of Transylvania.

Mineral water springs

Main topic here was management and future developement perspectives of mineral water springs. There is an abundance of mineral water springs due to Neogen and Quaternar volcanism in Seklerland which is located in Eastern part of Transylvania, so it was the main case study area. A lot of local people use the water from these springs for drinking purposes, but only some of these springs have some sort of establishments. In many cases these springs are not protected that raises many issues related to contamination and sanitation. The other unique use of Seklerlands mineral waters are the local baths, called popular baths, a traditional and simple way of bathing and enjoying the health cure of the mineral waters. During the field trip two of these baths and four of the most popular mineral water springs were visited.

Erasmus scholars in former spa Băile Cisar, Csiszárfürdő. Case of mineral water springs (10.07.2010).

Visit to mineral water springs trough bath Chirui, Nádasszék and Selters (08.07.2010).

Seminar organizers Zoltan Pal and Boglárka Czellecz guide in the replacement bus (10.07.2010).

Heavy rain and flooding in Praid as participatory hydrological survey (11.07.2010).

14th European Seminar on the Geography of Water Environmental Conflicts and Sustainable Water Policies in the Mediterranean Region

26.06. – 07.07.2011, Cagliari, Italy

Seminar programme

26.06.2011, Sunday, Arrival		

27.06.2011, Monday		
09:00	Opening Ceremony: welcome address by the University of Cagliari - V. Ledda, Pro-Rector for International Relations - A. Aloi, Manager for Students' Mobility and Erasmus Prgrm. - P. Piras, Dean of the Faculty of Political Science - G. Bottazzi, Dir. of the Dpt. of Social and Economic Research	
09:30	Introductory session: A. Corsale, M. Iorio, G. Sistu	Cagliari
10:30	Lectures on the theme "Physical and human geography and water-related conflicts and policies in the Mediterranean region and in Sardinia" P. Faggi, F. Lasserre, R. Cattedra, M. L. Gentileschi, S. Usai, A. Marini, A. Motroni, C. Jampaglia	
15:30	Poster presentations by the students (first session)	

28.06.2011, Tuesday		
09:00	Presentations by partner universities (first session) Lectures: R. Lončarić, M. Vetter, A. Guaran, B. Jansky, A. Järvet	
11:30	Presentations by partner universities (second session) Lectures: S. Piovan, L. Ronczyk, Z. Wilhelm, D. Zlatunova	
14:00	Poster presentations by the students (second session)	Cagliari
16:30	Working group sessions in tutored groups to determine objectives and methods of the upcoming work	
18:00	Visit to the old town and lectures on the urban history and geography of Cagliari: A. Pirinu, M. Memoli	

29.06.2011, Wednesday		
10:00	Visit to the Reservoir of Flumendosa	Reservoir of Flumendosa, Orroli
11:00	Lectures on the topic "Facing climate change and desertification. Water management in Sardinia" Lectures: A. Vacca, A. Virdis, V. Statzu, S. Podda	
13:00	Visit to the Prehistoric Fortress "Nuraghe Arrubiu"	Nuraghe Arrubiu
16:00	Visit to the Ethnographic Museum "Omu Axiu"	
17:00	Meeting in the Municipality of Orroli, A. Orgiana, Mayor of Orroli	Orroli

30.06.2011, Thursday		
10:30	Visit to the Visitor Center of the Marine Park of Capo Carbonara	Villasimius
11:30	Lectures on the topic "Sustainable water policies in tourist areas: the case of Villasimius": T. Sanna, R. Ghiani, B. Paliaga, E. Cabras	
14:00	Visit to the Wastewater Treatment Plant	
16:00	Visit to the beach, wetlands and sand dunes of Porto Giunco	Porto Giunco

01.07.2011, Friday		
10:00	Visit to the Centre for Environmental Education	Molentargius
11:00	Lectures on "Environmental conflicts and territorial planning in wetlands: the case of the Regional Park of Molentargius - Saline" Lectures: A. Atzeni, I. Contu	
15:00	Visit to the beach of Poetto	Poetto

02.07.2011, Saturday		
09:00	Visit to the Reservoir of Poggio dei Pini, M.R. Lai	Poggio dei Pini
10:30	Working group session	
17:00	Visit to the Museum of Laguna di Nora and tour of the lagoon by canoe, D. Fadda	Nora

03.07.2011, Sunday		
10:30	Visit to the old mines of Montevecchio and Ingurtosu	Montevecchio
14:00	Lectures on coast management and environmental impacts of mining activities Lectures: R. Cidu, A. Satta	
15:00	Visit to the sand dunes of Piscinas	Piscinas

04.07.2011, Monday		
09:00	Working group session (all day)	Cagliari

05.07.2011, Tuesday		
09:00	Working group session	Cagliari
16:30	Hike to the peninsula of Sella del Diavolo	
21:00	Social dinner with typical Sardinian food at the Terrace of Sant'Anna	

06.07.2011, Wednesday		
09:15	Plenary session: reports from the working groups	Cagliari
11:30	Discussion, scientific conclusions	
12:30	Certification award ceremony	
13:00	Presentation of the 15th European Seminar on Geography of Water by Dr. M. Vetter, University of Munich	
17:00	Visit to the Botanical Garden	

07.07.2011, Thursday, Departure

Participants

University of Padua, Italy
- Silvia Elena Piovan
- Giovanni Donadelli
- Michele Maritan
- Salvatore Pappalardo

University of Pecs, Hungary
- Levente Ronczyk
- Zoltan Wilhelm
- Gabriella Toth
- Krisztina Babák

Sofia University St. Kliment Ohridski, Bulgaria
- Petar Slaveikov
- Daniela Zlatunova
- Albena Petrova
- Panka Babukova
- Radostina Docheva

University of Tartu, Estonia
- Arvo Järvet
- Edgar Sepp
- Laura Altin
- Ramon Reimets
- Sirle Trestip

University of Sevilla, Spain
- Belen Pedregal Mateos
- Bilal Paladini San Martin
- Maria Villarin Claveria
- Sergio Segura Calero

Babeş-Bolyai University, Cluj-Napoca, Romania
- Nora Csilla Vicsai
- Boglarka Timea Czellecz

University of Udine, Italy
- Franca Battigelli
- Andrea Guaran
- Alice Barattin
- Lara Burigo

Charles University in Prague, Czech Republic
- Bohumir Jansky
- Andrea Blahušiakova
- Dana Kučerová
- Pavel Rygl

Ludwig Maximilian University of Munich
- Mark Vetter
- Carolin Schaffer
- Mario Kuttruff
- Rosa Wilm
- Stefan Weinberger

University of Zadar, Croatia
- Robert Loncaric
- Branimir Vukosav
- Ante Blace

University of Cagliari, Italy
- Andrea Corsale, academic chair
- Monic Iorio
- Monica Casu
- Annalisa Addis
- Filippo Menga
- Gianni Gaviano
- Michele Carboni

Working group topics

Environmental conflicts and territorial planning in wetlands: the case of theRegional Park of Molentargius – Saline

Wetlands have been heavily threatened and often irreversibly damaged by human activities over the past decades and centuries, in spite of their ecological significance. The Regional Park of Molentargius - Saline (1 600 ha) was established in 1999 in order to protect a vast coastal pond of international importance (included in the Ramsar Convention) as well as the ancient tradition of salt production within the urban area of Cagliari. The difficult coexistence of a metropolitan area inhabited by over 300 000 people and a delicate environment visited by rare species of birds provides interesting opportunities for sustainable territorial planning.

Sustainable water policies in tourist areas: the case of Villasimius

The coastal areas of the Mediterranean region are strongly characterized by competition for natural resources, particularly water, among different social and economic stakeholders. The town of Villasimius is one of the main tourist resorts in Sardinia (over 500 000 official tourist stays there every year, compared to only 3 000 permanent inhabitants) and experienced a progressive transformation from a mass tourism resort, during the 1980s and early 1990s, to a more and more ecologically-oriented destination, with interesting experiments related to water saving and recycling that have been recognized and prized as best practices at the European level.

Facing climate change and desertification: the case of the network of reservoirs in inner Sardinia.

Decreasing rainfalls and desertification processes have been recorded in many arid and semi-arid environments over the past decades, particularly in the Mediterranean region. Sardinia suffers from recurrent and severe water shortages and increasing conflicts among different uses, with agriculture accounting for over 60% of total consumption. An early policy of supply expansion led to the construction of 58 large dams, one tenth of the Italian total. These reservoirs and their water resources need careful and innovative management in order to better face possible climate changes and new water crises.

Seminar participants at the opening session at the University of Cagliari, chaired by Dr. Andrea Corsale (27.06.2011).

The outdoor lecture on the urban history and urbanisation in the Cagliari old town (28.06.2011).


Visit to the reservoir of Flumendosa, one of the many water collection reservoirs in Sardinia (29.06.2011).


The beach of Porto Giunco near Villasimius, studying mass tourism impacts (30.06.2011).

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15th European Seminar on the Geography of Water Modeling and Management of Water Quality in European Lakes and Reservoirs ─ Impacts of Climate Change

15.07. – 25.07.2012, Munich-Fischbachau, Germany

Seminar Programme

15.07.2012, Sunday, Arrival		
16.07.2012, Monday		
10:00	Welcome by prof. Mark Vetter and Prof. Otfried Baume (Chair of Physical Geography and Landscape Ecology LMU)	Department of Geography, Munich
10:20	Keynote lecture, Prof. Ralf Ludwig, Vice Dean of Faculty of Geosciences LMU	
11:15	Presentation on the IP Seminar programme, Stefan Weinberger	
13:30	Guided university tour, Prof. Susanne Döring	LMU main building, Munich
15:30	Guidded city tour, Katharina Link	
18:30	Icebreaker cocktail dinner meets piano	
17.07.2012, Tuesday		
09:30	Antti Roose, University of Tartu	Fischbachau
10:00	Prof. Bohumir Jansky, University of Prague	
10:50	Student poster presentations	
11:50	Introduction to scientific topics of working groups	
14:00	Working group session	
17:30	Steering meeting for professors	
18.07.2012, Wednesday		
10:00	Presentation on hydropower utilization at river Lech, LEW and BEW GmbH	Langweid, Lech Museum
12:30	Discussion and working group meetings	
19.07.2012, Thursday		
09:00	Prof. Andrea Corsale, University of Cagliari	Fischbachau
09:30	Prof. Leandro Del Moral Ituarte, University of Sevilla	
11:00	Visit to Mangfall drinking water supply plant, Stadtwerke München	Thalham, Weyarn
15:00	Students poster presentations	
17:00	Meeting with Mr. Josef Lechner, Mayor of Fischbachau, Presentation on water concept	Fischbachau

20.07.2012, Friday		
10:00	Visit to energy plant test area, Prof. Klaus Wiesinger, Bavarian Agricultural Research Institute	Freising
12:30	Visit to biogas plant	
14:30	Water management of ERDINGER brewery (including guided tour and Bavarian dinner "Brotzeit")	Erdinger brewery, Erding
21.07.2012, Saturday		
09:00	Welcoming and introduction to topics of the dissemination day, Prof. Friedrich Barnikel, Educational Coordinator of Geography, City of Munich	Fischbachau
09:15	Dissemination activities with teachers (all day)	
22.07.2012, Sunday		
09:00	Prof. Arvo Järvet, University of Tartu	Fischbachau
09:30	Prof. Robert Lončarić, University of Zadar	
10:00	Prof. Silvia Piovan, University of Padua	
10:50	Student poster presentations	
12:00	Working group meetings	
18:00	Prof. Ronczyk Levente, University of Pécs	
23.07.2012, Monday		
09:00	Visit to Lake Schliersee and presentation on lake tourism, Mr. Mathias Schrön, Guest Information	Kursaal, Schliersee
11:45	Walk to Mountain Chalet	Kreuth
16:00	Presentation on water supply and use in mountain areas, German Alpine Club (DAV)	Tegernseer Hütte
24.07.2012, Tuesday		
14:00	Visit to Walchensee Hydro Power Plant, E.ON Energie	Walchensee
17:30	Steering meeting for professors, working group meetings for students	Fischbachau
25.07.2012, Wednesday		
09:00	Presentation of the results of working groups 1 & 2	Fischbachau
11:20	Presentation of the results of working group 3	
12:20	Preview presentation University of Zadar	
12:40	Farewell presentation University of Munich	
18:00	Social dinner	Munich
26.07.2012, Thursday, Departure		

Participants

University of Cagliari, Italy
- Andrea Corsale

University of Padua, Italy
- Silvia Piovan
- Mauricio Nicolas Vergara

University of Pecs, Hungary
- Levente Ronczyk
- Reka Balogh
- Enikö Somi
- Gabriella Tóth

Sofia University St. Kliment Ohridski, Bulgaria
- Panka Babukova
- Stefan Radev
- Niya Shekerova

University of Tartu, Estonia
- Arvo Järvet
- Antti Roose
- Laura Altin
- Andreas Porman
- Edgar Sepp

University of Sevilla, Spain
- Leandro del Moral
- Sergio Segura Calero
- Bilal Paladini San Martín
- Salvador Trevijano Dalebrook
- Violeta Cabello Villarejo

University of Udine, Italy
- Franca Battigelli
- Andrea Guaran
- Isabella Boscarato
- Daniela Saturnino

Charles University in Prague, Czech Republic
- Bohumir Jansky
- Milada Matouskova
- Andrea Blahušiaková
- Jana Kaiglova
- Pavel Rýgl

Babeş-Bolyai University, Cluj-Napoca, Romania
- Boglárka Czellecz
- Boglárka-Mercedesz Kis
- Béla Szász
- Ágnes Boér

University of Zadar, Croatia
- Robert Lončarić
- Branimir Vukosav
- Ante Blaće
- Andrea Deklić
- Krešimir Samodol

Ludwig Maximilian University of Munich
- Mark Vetter, academic chair
- Stefan Weinberger
- Thomas Büche
- Sascha Jachish
- Christian Becker
- Friedrich Barnikel

Working group topics

Aquatic and climate change modeling

- Regional climate modeling
- Adaption of input parameters
- Hydrodynamic modeling
- Aquatic ecosystem modeling
- Validation of the models
- Discussion and evaluation of climate change impacts on lakes and reservoirs

Water related issues of energy plant cultivation in the catchment area of Lake Ammersee

- Landuse analysis with GIS
- Landscape balance changes due to bio fuel plantation
- Generation of scenarios respective landuse changes
- Impacts on water quality
- Economic analysis
- Social and ethnic issues, fuel or food?
- Discussion and evaluation

Lakes as magnets of tourism in Upper Bavaria

- Social and cultural impacts of tourism on lakes in Upper Bavaria
- Generation of a socio-scientific model to reproduce aspects of recent lake-tourism
- Generation of future scenarios
- Sustainable solutions
- Discussion and evaluation

Erasmus scholars in Tegernseer Hütte (altitude 1650m MSL). Discussion on water supply and use in high mountain conditions (23.07.2012).

Presentation at energy plant test area in Freising (20.07.2012).

Working group session in Fischbachau (21.07.2012).

Farewell party and social dinner with traditional Bavarian features at LMU's geography department, Andrea Guaran (left) and Stefan Weinberger (right) in action (25.07.2012).

16th European Seminar on the Geography of Water Water Management in Coastal and Insular Karst Areas

07.07. – 18.07.2013, Zadar, Croatia

Semianar programme

07.07.2013, Sunday, Arrival		
08.07.2013, Monday		
10:00	Opening ceremony at the main university building: Welcome address by the Rector of the University of Zadar and the Head of the Department of Geography	
10:45	Introductory session: Presentation of the IP programme, objectives and methodology. General and Keynote lectures of the seminar	Zadar
14:00	Keynote lectures of the working groups	
15:30	Guided tour of the University and the old town	
09.07.2013, Tuesday		
08:00	Half-day fieldtrip to Vransko jezero Lake nature park. Visit to the study area, collection of data, meeting with local stakeholders.	Vransko jezero
15:30	Presentations by: Andrea Corsale, University of Cagliari Carlo Perelli, University of Cagliari	
17:15	Working group session	Zadar
18:30	Steering meeting for professors	
10.07.2013, Wednesday		
08:00	Visit to the Modrič Cave	Rovanjska
16:15	Presentations by: Andrea Guaran, University of Udine, Bohumir Jansky, Charles University of Prague, Arvo Järvet, University of Tartu	Zadar
18:00	Poster presentations by students	
11.07.2013, Thursday		
08:30	Presentations by: David Sampedro Sánchez, University of Seville; Zoltan Pal; University of Cluj, Silvia Piovan, University of Padua	
10:30	Presentations by: Antti Roose, University of Tartu; Mark Vetter, University of Applied Science Karlsruhe; Zoltán Wilhelm, University of Pécs	Zadar
12:15	Student poster presentations	
15:00	Student poster presentations	

12.07.2013, Friday		
08:30	One-day boat fieldtrip to the Telašćica Nature Park and Dugi otok Island (Visit to the study area, collection of data, meeting with local stakeholders)	Sali, Dugi otok Island, Telašćica Nature Park
11:00	Visit to the Sali settlement	
12:30	Visit to the Telašćica Nature Park	
13.07.2013, Saturday		
09:00	Krka National Park (Visit to the study area, collection of data, meeting with local stakeholders)	Krka National Park
14.07.2013, Sunday		
08:30	Trip to the Zadar's hinterland. Visit to the study area, collection of data, meeting with local stakeholders	Zadar hinterland
14:00	Trip to Pag Island	Pag, Novalja, Pag island
15:30	Visit to the Veliko blato lake, town of Pag, Museum of salt; Roman aqueduct in Novalja	
15.07.2013, Monday		
08:00	Fieldtrip in Paklenica National Park. Visit to the study area, collection of data, meeting with local stakeholders	Paklenica National Park
16:30	Working group session	Zadar
16.07.2013, Tuesday		
08:30	Presentations by: Milada Matoušková, Charles University of Prague; Daniela Zlatunova, University of Sofia	
09:30	Working group session	Zadar
14:30	Working group session, compiling final results and preparing the presentations	
17.07.2013, Wednesday		
09:00	Plenary session: Reports from the working groups	
11:00	Discussion, scientific conclusions. Evaluation and assessment of the seminar. Feedback. Preview presentation University of Padua	
14:30	Meeting of consortium members. Planning follow-up of the programme. Dissemination activities at Zadar City Library	Zadar
17:00	Certification award ceremony at the Department of Geography	
20:00	Social dinner with traditional Dalmatian food and music	
18.07.2013, Thursday, Departure		

Participants

University of Cagliari, Italy
- Carlo Perelli
- Gabriela-Mihaela Afrasinei

University of Padua, Italy
- Silvia Piovan
- Davide Cirillo
- Chrysafina Geronta
- Sara Bonati

University of Pecs, Hungary
- Wilhelm Zoltan
- Andrea Horváth
- Elisabeth Magyar
- Gabriella Tóth
- Viktória Nemes

Sofia University St. Kliment Ohridski, Bulgaria
- Panka Babukova
- Stefka Paraskevova
- Valentin Kostadinov

University of Tartu, Estonia
- Antti Roose
- Arvo Järvet
- Edgar Sepp
- Laura Altin

University of Sevilla, Spain
- Belen Pedregal Mateos
- Bilal Paladini San Martin
- Davide Sampedro Sanchez
- Lucía Otero Monrosi

University of Udine, Italy
- Andrea Guaran
- Daniela Saturnino
- Isabella Boscarato
- Rita Grisot

Charles University in Prague, Czech Republic
- Bohumir Jansky
- Milada Matouskova
- Andrea Blahušiaková
- Jana Kaiglova
- Lukáš Vlček

Babeş-Bolyai University, Cluj-Napoca, Romania
- Zoltan Pal
- Amália Györgyi Kassay
- Boglárka Timea Czellecz
- Sebestyén Tihamér-Tibor

University of Zadar, Croatia
- Robert Lončarić, academic chair
- Ante Blaće
- Branimir Vukosav
- Maša Surić

Ludwig Maximilian University of Munich
- Mark Vetter
- Stefan Weinberger
- Teresa Heidemann
- Thomas Bueche
- Christian Becker

Working group topics

Water on islands – a question of survival: study of the Zadar archipelago

One of the basic characteristics of the Croatian part of the Adriatic Sea is its large archipelago. Throughout the history, the islands were isolated areas with the traditional economies based on agriculture and fishery. The main setback of the economic and social development on the islands, both in history and today, has been the insufficient water supply which especially referred to the smaller offshore islands. The reason for the lack of surface water has been the dominant karst relief in spite of the fact that the annual rainfall ranges from 700 to 1200 mm. Within such circumstances, various types of traditional water supply (old water tanks, wells, ponds, collecting rainwater, transportation of water from the mainland) have been used to meet the needs of population. On the other hand, the Island of Pag, with its non-permeable flysch deposits which act as a hydrological barrier, exhibits relative abundance of surface water. However, with the transformation of the islands' economies towards tourism and services, the needs for water on the islands grow rapidly, creating a pressure on the existing water supply systems.

Conflict of environmental protection and agriculture: a case of the Vransko jezero Lake nature park

Agricultural zones in Mediterranean karst regions have had extraordinary significance for the inhabitants' existence. One of such zones is located near Vransko jezero Lake in Zadar County in Littoral Croatia. Vransko jezero Lake is the largest lake in Croatia (30 km^2) and it is one of the rare natural habitats of water birds remaining in the Mediterranean. Because of its rich biodiversity of flora and fauna and fresh water springs, Vransko jezero Lake and its surroundings have been proclaimed a nature park in 1999. But natural balance of the lake is being more and more endangered by traditional agriculture activities and contemporary food production facilities. Conflicts between local population and Park Authorities are becoming more frequent in recent years, therefore, satisfactory solution for both parties is needed.

Indicators of sea-level and climate changes: examples from Zadar's region

During the late Pleistocene – Holocene period, palaeoenvironmental changes of the Eastern Adriatic coast were mostly caused by sea-level fluctuations induced by global climate change. Area surrounding Zadar is characterized by rocky karstified coast, low tidal range, indented shoreline with numerous islands, abundant palaeontological, archaeological and historical evidences, which offer optimal prerequisite for sea-level change studies. Among karst deposits, submerged speleothems are often used as the primary record source of sea-level while coastal speleothems are used as indicators of palaeoclimatic changes. Most palaeocilimatic researches are conducted in the Modrič Cave, some 30 km from Zadar. Remains of man-made objects, such as port facilities, docks, fish ponds, built during the Roman rule, also provide firm evidence of the sea-level change in the last 2000 years. Such evidences are found throughout Zadar's Archipelago, namely on the Pag Island, Kornati Islands National Park, etc.

Erasmus scholars on Pag island in Zadar archipelago (14.07.2013).

Field trip to Vransko jezero nature park and view to Zadar Archipelago (09.07.2013).

Visiting the Modrič cave in the village Rovanjska, length 836 m (10.07.2013).

Walk over "The Greeting to the Sun" in the Zadar waterfront, ferry terminal in the background (08.07.2013).

17th European Seminar on the Geography of Water Geo-historical Evolution of the Waters in the Southern Venetian Plain

22.06. – 03.07.2014, Padova, Italy

Seminar Programme

22.06.2006, Sunday, Arrival		
23.06.2006, Monday		
09:30	Opening ceremony: - Welcome address by the Head of Geography Section and the Head of the Department of Historical Geographical and Antiquity Sciences. - Introductory session by the coordinators from Tartu and Padova	
11:00	Geological and geomorphological setting of the Venetian Po Plain, A. Fontana The Landscape changes in the Venetian Plain, B. Castiglioni	Padova
12:00	Visit to the University Main Building	
15:00	Visit to Padova historical city centre	
24.06.2006, Tuesday		
08:30	Presentations from partner Universities 1	
11:00	Student poster session 1	
13:30	Presentations from partner Universities 2	Padova
16:00	Student poster session 2	
18:00	Departure to the Po Delta and new accommodation	
25.06.2006, Wednesday		
08:30	Stakeholder workshop	Delta Po
10:00	Walk to the Po di Goro inlet, lectures: "Stakeholders and territory in the Po Delta region" and the "Evolution of Po Delta palaeohydrography", M. Bertoncin and S. Piovan)	Santa Maria in Punta
14:30	Field trip in Valli	Valli
19:30	Working group session	Rifugio al Paesin
26.06.2006, Thursday		
09:00	Ca' Vendramin Museum and lecture of G. Mantovani	Delta Po
11:00	Visit to the Cooperative Fisching Consortium, E. Rossetti	Scardovari
15:00	Boat tour in Po Delta	Boccasette

27.06.2006, Friday		
08:30	The evolution of the Man-water relationships in the Adige-Po alluvial plain in the Late Holocene, S. Piovan	Rifugio al Paesin
10:30	Visit to Museum Grandi Fiumi	Rovigo
12:30	Visit to Museum of Roman Age Centuriation - Villadose	
15:00	Free time at Porto Caleri beach	Porto Caleri
28.06.2006, Saturday		
09:30	Visit to Ca' Bianca pumping station	Ca' Bianca
12:00	Keynote lecture by Prof. M.E. Hodgson (University of South Carolina - USA) on "Stages of the Hazard Cycle and Flooding" Land Reclamation in Polesine area, E. Novello	Codevigo
14:30	Meeting with the major of Anguillara Veneta and short presentation by Tommaso Ferrari on natural and anthropogenic wetlands in Polesine and Bassa Padovana.	Anguillara Veneta
17:00	Working group session	Padova
29.06.2006, Sunday		
09:30	Padova underground, a geoarchaeological investigation of the city's palaeohydrography, P. Mozzi The evolution of canals around Padova, U. Fadini	Padova
11:00	Working group session	
14:00	Boat tour around Padova: "The navigable water ring around the city", U. Fadini	
30.06.2006, Monday		
09:30	The role of urban waters in the Botanical Garden of Padova, A. Miola	Padova
10:00	Visit to the Botanical Garden of Padova, A. Miola	
14:30	Field trip in Padova city centre: the evolution of urban canals, E. Caravello	
01.07.2006, Tuesday		
09:00	Working group session. Data elaboration, final results, preparation of the presentations	Padova
10:30	Steering meeting of professors. Planning follow-up of the programme	
02.07.2006, Wednesday		
09:00	Plenary session: Reports from the working groups, discussion, scientific conclusions	Padova
11:00	Evaluation and assessment of the seminar and feedback	
14:30	Presentation of the 2013 Proceedings	
15:00	Certification award ceremony	
20:00	Social dinner	
03.07.2006, Thursday, Departure		

Participants

University of Pecs, Hungary
- Levente Ronczyk
- Julia Danko
- Elisabeth Magyar
- Manuel Toth

Sofia University St. Kliment Ohridski, Bulgaria
- Daniela Zlatunova
- Panka Babukova
- Valentin Kostadinov
- Niya Shekerova

University of Tartu, Estonia
- Antti Roose
- Arvo Järvet
- Laura Altin
- Morten Jõgi
- Rain Kärner

University of Sevilla, Spain
- Belen Pedregal
- Chiara Briatico
- Miguel Garcia Martin
- Josè Louis Mellado Blanco

University of Cagliari, Italy
- Andrea Corsale
- Valentina Sanna

University of Udine, Italy
- Franca Battigelli
- Andrea Guaran
- Rita Grisot

Charles University in Prague, Czech Republic
- Bohumír Jansky
- Milada Matouskova
- Kateřina Fraindová
- Katerina Marouskova
- Kristyna Falatkova

Babeş-Bolyai University, Cluj-Napoca, Romania
- Zoltan Pal
- Bettina Balog
- Alpar Csegzi
- Boglarka Czellecz

Ludwig Maximilian University of Munich
- Mark Vetter
- Lisa Baumeister
- Thomas Bueche
- Teresa Heidemann
- Stefan Weinberger

University of Zadar, Croatia
- Robert Loncaric
- Branimir Vukosav

University of Padua, Italy
- Silvia Piovan, academic chair
- Mauricio Vergara
- Angelica Dal Pozzo
- Michael E. Hodgson
- Marina Bertoncin
- Daria Quatrida
- Tommaso Ferrari

Working group topics

Actors and Territorial Strategies

The Venetian area could be considered a "natural" laboratory to study conflicts involving the economical and the political management of water in a very densely populated alluvial-coastal plain. In particular, the Padova city and Po Delta area offers two examples, at different scales, to analyze the stakeholder concerns that drive the territorial strategies, and often result in conflicts, related to management of water resources.

A current debate in the city of Padova concerns the re-opening of the urban canals (buried during the last century, especially during the 1950s) for the reorganization of the urban traffic and the "re-qualification" of the city centre. The debate involves public administrations, cultural associations and public opinion, and includes the historical role of canals. Such a debate offers an ideal case-study to probe present-day reasons for re-thinking the management of urban waters.

The Po Delta located in the southeastern part of Veneto region, presents an emblematic case of territorial conflicts due to the coexistence of the interregional park, instituted in 1997, the Porto Tolle thermoelectric plant and agricultural, fishing and hunting activities. The park management plan is to 1) protect, restore, enhance and preserve the natural, historical and cultural heritage of the Delta, 2) ensure adequate promotion and protection of typical economic activities of the area, and 3) contribute to the improvement of the local communities' quality of life. However, the management plan goals may be in conflict with a complex set of interests from different stakeholders. The main aim of this working group is to understand and analyze territorialization processes, actors and relational dynamics of power in the case studies.

Flooding and flood water mitigation

The alluvial plain is one of the most common forms of the natural landscape. The distinctive feature of the southern Venetian plain is that of being crossed by four large rivers – Po, Adige, Brenta and Bacchiglione – which, from a geomorphological point of view, shaped the alluvial plain during Pleistocene and Holocene.

Over time, these rivers made the plain a good place for human settlements and served as a regional and superregional link between the Alps and the Adriatic Sea. The rivers acted not only as communication lines and trade routes but also as significant sources of water and food. Over time the rivers served many other activities, such as worship, recreation and energy production.

However, rivers also present a flood hazard for human life and activities. Flood events as those of Po (1951), Adige (1882), Brenta (1966) and Bacchiglione (2010) are only a few recent examples in a long series.

The city of Padova, as well as the Adige-Po alluvial plain, offers relevant case studies to study flood-mitigation strategies in two different geographic contexts.

Environmental and cultural tourism

Since the proto-historic times, in the southern Venetian alluvial plain, the rivers both guided settlements and encouraged trade up to the Baltic region, while the anthropogenic activities imposed radical changes in the natural water-related forms as rivers, streams, swamps and coastlines.

The urban center of Padova and alluvial plains of Bassa Padovana and Polesine provide case studies of different palaeohydrographic elements and anthropogenic structures related to the waters. Such physical and cultural elements include ancient bridges, alluvial ridges, meander cut-offs, industrial archeological sites (e.g. pumping stations), ancient siphon bridges, and canals. The elements are of great interest not only from geomorphological and historical points of view but also by the tourism perspective.

What are the metrics that can help us in identifying and ranking the features, both natural and anthropogenic, that can be considered environmental and/or cultural heritage related to the waters? How they can be valorised for a sustainable tourism and a local development of the study area? Who are the tourists we wish to attract?

Education and Culture DG

Lifelong Learning Programme

CERTIFICATE OF ATTENDANCE

This is to certify that

Arvo Jarvet

has participated to the 13th Erasmus Intensive Programme on

Geography of water

Community Scale Water Management patterns in Transylvania

4-15. July 2010

which took place at the University of Cluj-Napoca, Romania

Prof. Dr. Dan Petrea
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