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**CASCAIS**  
MUNICIPALITY

CASCAIS WORLD FORUM 2012

# SOIL BIOENGINEERING AND LAND MANAGEMENT NEW CHALLENGES

## Sustaining Our Land, Water and Life in Changing Climate

II Congress APENA - VII Congress AEIP – VI Congress EFIB

Cascais, Portugal, 19-22 September 2012



*Presidência da República*

Under the High Patronage of His Excellency  
the President of the Portuguese Republic



## A) GENERAL INFORMATION

EFIB (European Federation for Soil Bioengineering), APENA (Associação Portuguesa de Engenharia Natural), Portugal ([www.apena.pt](http://www.apena.pt)) and AEIP (Asociación Española de Ingeniería del Paisaje), together with Cascais Municipality, cordially invite you to our International Congress, under the title "Bioengineering and Land Management - New Challenges" to be held September 19 (Wednesday) -22 (Saturday), 2012, at Cascais, Portugal.

### About

The theory of the four basic elements - water, soil, air, and fire, proposed by Empedocles (ca. 490-430 BC), remained commonly accepted for more than 2000 years. While science has improved dramatically, upon Empedocles' notions, researchers today are often so specialized that they lose sight of the multiple elements. We are considering these last elements as they are manifestations in relation to:

- the current challenges and trends, in Bioengineering, Ecology and Sustainability Solutions.
- the United Nations Conference on Sustainable Development (UNCSD), held in Brazil in June 2012, 20 years after the Rio Summit 1992 and 10 years after the Johannesburg Summit 2002.

### Objectives:

- Provide a global venue, with scientific sessions and world-known speakers, for professionals, decision makers, researchers and students from diverse backgrounds, including the earth sciences, bioengineering, landscape architecture, natural resources, land management and public policies.
- Discuss new developments in the science and practice of low-cost, effective solutions, in bioengineering.
- Identify biodiversity and ecosystem aspects useful to establish the ecological status of landscapes.
- Promote tools for a more appropriate land management, especially in urban and peri-urban areas.
- Provide practical solutions to the imbalances between Nature and Humanity, in communion with the results of Rio +20 Summit, to be held in June 2012.



- Amplify knowledge and experience of EU Water Framework Directive (WFD) and other policies involved in soil restoration and landscape management.

#### **Scientific Areas:**

1. Landscape and Land Management
2. Slope Stabilization & Restoration
3. Fluvial and Coastal Stabilization & Restoration
4. Ecological Quality and Biodiversity
5. Combating Desertification
6. Rainwater Harvesting
7. Recuperation and Renaturalization of Degraded Areas
8. Requalification and Rehabilitation in Urban and Peri-Urban Areas
9. Greenways
10. Policy Implementation for Land Restoration and Conservation

#### **Official languages: English, Spanish and Portuguese**

Conference Venue: Centro Cultural de Cascais, Cascais, Portugal  
(GPS: N 38° 41' 38.92", W 9° 25' 17.38")

#### **Co-Sponsorship:**

1. Associação Portuguesa de Corredores Verdes (APCV), Portugal ([www.apcverdes.org](http://www.apcverdes.org))
2. Associação Portuguesa de Ecologia da Paisagem (APEP), Portugal ([www.apep.pt](http://www.apep.pt))
3. Centro Ibérico de Restauração Fluvial (CIREFL), Portugal and Spain ([www.cirefluvial.com](http://www.cirefluvial.com))
4. Associazione Italiana per la Ingegneria Naturalistica (AIPIN), Italy ([www.aipin.it](http://www.aipin.it))
5. Verein für Ingenieurbiologie, Switzerland ([www.ingenieurbiologie.ch](http://www.ingenieurbiologie.ch))
6. Gesellschaft für Ingenieurbiologie e.V., Germany ([www.ingenieurbiologie.com](http://www.ingenieurbiologie.com))
7. Association Française de Génie Biologique pour le Contrôle de l'Érosion des Sols (AGEBIO), France ([www.agebio.org](http://www.agebio.org))
8. Fachvereinigung Betriebs- und Regenwassernutzung (FBR), Germany ([www.fbr.de](http://www.fbr.de))
9. Universidade Católica Portuguesa - Faculdade de Engenharia, Lisbon, Portugal ([www.fe.lisboa.ucp.pt](http://www.fe.lisboa.ucp.pt))

10. Universidade Técnica de Lisboa - Instituto Superior de Agronomia, Lisbon, Portugal ([www.isa.utl.pt](http://www.isa.utl.pt))
11. Universidade de Trás-os-Montes e Alto Douro (UTAD) ([www.utad.pt](http://www.utad.pt))
12. Universität für Bodenkultur Wien (BOKU), Austria ([www.boku.ac.at](http://www.boku.ac.at))
13. Technische Universität Berlin, Berlin, Germany ([www.tu-berlin.de](http://www.tu-berlin.de))
14. University of California - Berkeley, USA (<http://berkeley.edu>)
15. Universidade Federal do Paraná, Curitiba, Brasil ([www.ufpr.br](http://www.ufpr.br))
16. University of Florida, USA ([www.ufl.edu](http://www.ufl.edu))
17. Universidade Federal de Santa Maria, Santa Maria, Brasil ([www.ufsm.br](http://www.ufsm.br))
18. University of New Orleans - Pontchartrain Institute for Environmental Sciences (UNO-PIES), USA ([www.pies.uno.edu](http://www.pies.uno.edu))
19. Universidade de Lisboa - Centro de Estudos Geográficos (UL-CEG), Portugal ([www.ceg.ul.pt](http://www.ceg.ul.pt))

**Forum Proceedings:** A book of abstracts is available for each participant. Selected papers of the proceedings will be the subject of a specific book. Manuscripts to be submitted for publication in the proceedings will be collected at the Forum.

#### **Committee Compositions:**

##### *1 Honor Committee*

1. Aníbal Cavaco Silva (President of the Portuguese Republic)
2. Pedro Passos Coelho\* (Prime Minister of Portugal)
3. Assunção Cristas\* (Minister of Agriculture, Sea, Environment and Regional Planning)
4. Daniel Campelo\* (Secretary of State for Forestry and Rural Development)
5. Pedro Afonso de Paulo\* (Secretary of State for Environment and Regional Planning)
6. Paula Sarmento (President of the Institute for Nature Conservation and Biodiversity)



7. Manuel Braga da Cruz (Rector of the Universidade Católica Portuguesa)
  8. Carlos Manuel de Jesus Carreiras (Mayor of Câmara Municipal de Cascais)
- (\*): to be confirmed

## 2 Organizing Committee

1. Jose Matos Silva (Chair)\* (APENA, UCP); Portugal
  2. Paola Sangalli (Vice-Chair)\* (AEIP), Spain
  3. Joao Melo (CMC), Portugal
  4. Rui Cortes (CIREF, UTAD), Portugal
  5. Pedro Martinho\* (APENA), Portugal
  6. Vasco Silva\* (CMC), Portugal
  7. Eike Flebbe (APENA)\*, Portugal
  8. Eva Hacker (EFIB), Germany
  9. Pilar Barraqueta (AEIP), Spain
  10. Albert Sorolla (AEIP), Spain
  11. Carlo Bifulco\* (APENA, AIPIN, ISA), Portugal
  12. Florin Florineth (EFIB, BOKU), Austria
  13. Joao Azevedo (APEP, IPB), Portugal
  14. Carlos Mendonca (BMC), Portugal
  15. Artur Ribeiro\* (APENA), Portugal
  16. Rui Teles\* (APENA), Portugal
  17. Pedro Tomás\* (APENA), Portugal
  18. Aldo Freitas\* (APENA), Portugal
- (\*): Executive Committee

## 3 Scientific Committee

1. Eva Hacker (Chair) (President of EFIB, Professor at Hannover University, Germany)
2. Jose Matos Silva (Vice-Chair) (President of APENA, Professor at Lisbon Catholic University, Portugal)
3. Paola Sangalli (Founder and President of AEIP, Spain)
4. Giuliano Sauli (Founder and President of AIPIN, Italy)
5. Francisco Castro Rego (Professor at ISA- Lisbon, Director of CEABN, APCV, Portugal)

6. Rui Cortes (Professor at UTAD, Vice-President of CIREF, Portugal)
7. Mathias Kondolf (Professor at the University of California, Berkeley, USA)
8. Florin Florineth (Professor at BOKU, Vienna, EFIB, Austria)
9. Freddy Rey (Research Fellow, Cemagref de Grenoble, President of AGEBIO, France)
10. Maurício Balensiefer (Professor at UFPR, Curitiba, President of SOBRADE, RIACRE, Brazil)
11. Francisco Escobedo (Professor at SFRC, University of Florida, USA)
12. Fabrício Sutili (Professor at UFSM, Santa Maria, Brazil)
13. Joao F. Pereira (Post-Doctoral Researcher at UNO-PIES, USA)
14. Marco Schmidt (Professor at Technische Universität Berlin, Berlin, Germany)
15. Diogo de Abreu (Professor at UL, Director of CEG, Portugal)
16. João Azevedo (President of APEP, Professor at IPB, Portugal)

## B) PRESENTATIONS AND ESTABLISHED TIMETABLES

Presentations will be made in the form of lectures or posters. Oral presentations will be grouped by topic and limited to 15 to 30 minutes, depending on the program.

Posters will be on display throughout the forum days. In the coffee- and lunch-breaks, participants will have greater opportunity to watch them, ask questions and clarify doubts about them.

Do not expect a mundane international event, open to everyone, but rather a Stakeholders Reunion.

There was a large affluence to this Forum. At the same time, at the request of most people, there will be no parallel sessions. And, there is no money to pay simultaneous translations and rent of the corresponding equipment. We are also aware that, in addition to the three official languages, there are colleagues, e.g., from Italy, Germany, Austria and USA, who only speak and understand well their native languages.

All this involves an **intense program**, and **good will of all**. Hence, we appeal to all participants, to collaborate with us and **meet** the tight **established timetables**.

## C) APPLICATION FORM AND REGISTRATION FEES (EUROS):

First Name: \_\_\_\_\_ Last Name: \_\_\_\_\_  
 E-mail: \_\_\_\_\_ Tel: \_\_\_\_\_  
 Address: \_\_\_\_\_ Post Code: \_\_\_\_\_  
 City: \_\_\_\_\_ Country: \_\_\_\_\_

(Please, send copy of the Application Form and Bank Transfer, with name, to [cascaiswf2012@cascaisnatura.org](mailto:cascaiswf2012@cascaisnatura.org))

Status	Fees (Euros)	
EFIB Members(*)	Regular	340€
	Low/Middle Income Country*	290€
	Full-time Student**	170€
Non Members	Regular	400€
	Low/Middle Income Country*	310€
	Full-time Student**	220€
Accompanying Persons	125€	

(\*) Members of National Associations affiliated with EFIB.

(\*\*): See the World Bank country listing for Low-income, Lower-middle-income and Upper-middle-income.

(\*\*): Only those who are full-time undergraduate or graduate students at the time of the conference, or who have graduated within 6 months prior to the conference date, qualify for a student rate. Once you complete your registration, please send us proof of your student status (a scanned copy of your student ID card, confirmation of enrollment, acceptance letter, etc.).

### Notes:

- All fees are in Euros.
- The conference full registration fee includes participation in sessions, conference materials and catering breaks. It also includes one ticket for the Welcome Dinner, on Wednesday, September 19.

- The conference student registration fee includes participation in sessions, all conference materials and day time catering at the conference, but it does not include entry to the conference dinner. Special tickets are available until Wednesday, September 19, in the morning, for 15 Euros/seat.
- Attendees' registration and social function ticket fees do not include insurance of any kind.

### Payment:

Account Holder: APENA  
 Address: Rua Amoreiras, 101, 1250-020 Lisbon, Portugal  
 Bank: CGD  
 National Transfers: NIB: 0035 0373 0001 0665 3300 5  
 International Transfers:  
 IBAN: PT50 0035 0373 0001 0665 3300 5  
 BIC/SWIFT: CGDIPTPL

## D) INVITATION FOR SPONSORS

Organizations may find several opportunities and forms of participation:

- Submit a real problem, asking for proposed solutions;
- Dynamic interaction with the participants;
- Association of the organization name to the event.

## E) TOURISM

Cascais, Portugal, delimited by the Atlantic Ocean to the south and west, is one of the most pleasant regions in Europe, well known as a place of vast nature, heritage and cultural attractions. Located just a few kilometers away, Lisbon is one of the oldest European capitals, with all that this implies in terms of atmosphere, trade and culture. The region offers year-round warm temperatures. September is a popular time of the year for residents and tourists alike to stroll through the streets of Cascais to enjoy artisan displays, music and dance in the downtown plazas near Town Hall.

## G) PROGRAM:

Time	Tuesday	Wednesday	Thursday	Friday	Saturday
	Sep 18, 2012	Sep 19, 2012	Sep 20, 2012	Sep 21 2012	Sep 22 2012
8:00		Registration	Registration	Registration	
9:00		Opening Ceremony	Eva Hacker	M. Balensiefer	
9:15		Inaugural Lecture: Alex McCorqudale			
9:30			Giuliano Sauli	Bet Mota et al.	
9:45		João Pereira et al.		Pilar Barraquereta	
10:00		Grecia Teran et al.	Freddy Rey	A. Kozovits	
10:15		Rui Cortes et al	H. Peter Rauch	Bruno Barbosa	
10:30		Miguel Brito et al.	Sandro Holanda	Alberto Ayesa	
10:45		Questions & Answers	Q. & Answers	Q. & Answers	
11:00		Coffee Break	Coffee Break	Coffee Break	
11:30		Florin Florineth	Paola Sangalli	Rolf Studer	
12:00		Fabricio Sutili	Paolo Cornelini	Carla Antunes	
12:15		Clemens Weisteiner	Carlo Bifulco et al.	Pino Dononzo	
12:30		Jose Cardão et al.	Gonçalo Fonseca	Ciro Costagliola	
12:45		Questions & Answers	Q. & Answers	Q. & Answers	
13:00		Lunch Break	Lunch Break	Closing Session	
13:30				Lunch Break	
14:30	Registration	Jose M. Silva et al.	M. Valenzuela		
14:45			F. Correia et al.		
15:00		Graça Saraiva et al.	M. Leite et al.		
15:15		Mikel Sarriegi et al.	João Azevedo		
15:30		Marco Vicari et al.	Inês L. Fonseca		
15:45		Joaquim Jesus	Ana Filipa Leite		
16:00		Eike Flebbe et al.	Sara Santos et al.		
16:15		Kristian Ceppas	Q. & Answers		
16:30		Questions & Answers	Coffee Break		
16:45		Coffee Break			
17:00		Francisco Escobedo	Marco Schmidt		
17:30		Maria M. Silva	Tatiana Valada et al.		
17:45		Albert Sorolla et al.	Mariangela Leite		
18:00		Inês Correia et al.	Sofia Campo et al.		
18:15		Questions & Answers	Q. & Answers		
18:30	Round Table		Mathias Kondolf		
18:45			Anna Lobet		
19:00					
20:00	Ice Breaker and Port Wine Reception		Round Table		
20:30		Welcome Dinner	EFIB Meeting	Optional Tour "Lisbon by Night"	
	EXPO	EXPO	EXPO		

## H) CHAIRPERSONS AND INVITED SPEAKERS



**EVA HACKER**

President of EFIB (European Federation for Soil Bioengineering), Professor at Leibniz Universität Hannover, Germany. Main Fields: Bioengineering, Conservation, Landscape Planning.



**PAOLA SANGALLI**

Degree in Biology, Central University of Barcelona, and Master in Landscape Design (Polytechnic University of Valencia). President of AEIP (Asociación Española de Ingeniería del Paisaje), member of EFIB (European Federation Bioengineering, AEP (Asociación Española de Paisajistas), CIREF (Centro Ibérico para la Restauración Fluvial) and FEAP (Fédération Européen Architecture du Paysage). Professor in the Master of Lanscape Architecture Juana de Vega and at the Master in Landscape Architecture -EHU-UPV (University Basque Country). Organization and lecture of short courses and conferences in Soil Bioengineering, in various countries. Professional activity and experience in nursery, landscape and garden design and in bioengineering and ecological restoration.



**G. MATHIAS KONDOLF**

Fluvial geomorphologist and environmental planner, specializing in environmental river management and restoration. As a Professor of Environmental Planning at the University of California, Berkeley, he teaches courses in hydrology, river restoration, environmental science, and Mediterranean-climate landscapes, advises students in these subjects, and serves as Chair of the Department of Landscape Architecture and Environmental Planning. He is currently the Clarke Scholar at the Institute



for Water Resources of the US Army Corps of Engineers in Washington, and formerly served on the Environmental Advisory Board to the Chief of the Corps.



#### ALEX MCCORQUODALE

Freeport McMoRan (FMI) Professor of Environmental Modeling in the Department of Civil and Environmental Engineering at the University of New Orleans. He holds a Ph.D. in Hydraulic Engineering from the University of Windsor, Canada. He is currently director of the FMI Center for Environmental Modeling at the University of New Orleans. His research interests include physical and numerical modeling of environment processes involving flood control, hydraulics of water and waste water treatment systems, transient analyses of forcemains and water distributions systems and shore protection. He has published more than 100 refereed articles and three books. He has over forty year experience as a hydraulic consultant to engineering firms and government agencies in Canada and the United States.



#### GUILIANO SAULI

Degree in Natural Sciences, Sciences Trieste University (thesis in botany 110/110 cum laude). Founder and President of A.I.P.I.N. (Associazione Italiana per la Ingegneria Naturalistica), since 1990, and author of more than 300 projects and 200 publications and papers. Areas of research: Soil Bioengineering, Environmental Engineering and Environmental Impact assessment.



#### FLORIN FLORINETH

Head of Institute of Soil Bioengineering and Landscape Construction, Universität für Bodenkultur (BOKU), Vienna - Austria / Department of Civil Engineering and Natural Hazards / Institute of Soil Bioengineering and Landscape Construction (IBLB). Secretary of EFIB (European Federation for Soil Bioengineering).

Expertise: soil bioengineering; vegetation technology; botany; erosion (erosion control); torrents and avalanches research; soil science; construction technology; green area planning; soil science; environmental organization; landscape planning.



#### ROLF STUDER

Dep. Chairman of EFIB (European Federation for Soil Bioengineering), Vice-President of Verein für Ingenieurbiologie, Switzerland.



#### FREDDY REY

PhD Grenoble, Université Joseph Fourier Grenoble I. He works at Cemagref (Grenoble, France), as a Forest Engineer and Doctor of Management of Mountain Areas. President of AGE BIO (Association Française de Génie Biologique pour le Contrôle de l'Érosion des Sols). Areas of research: Interactions between vegetation and erosion, restoration ecology applied to community eroded mountain, ecological engineering.



#### MARCO SCHMIDT

Marco Schmidt studied Landscape Architecture and Environmental Planning in Berlin. He worked on various urban ecological demonstration projects, commissioned by the Berlin Senate for Urban Development and the Federal Ministry of Economics and Technology. Main focus is the evaluation of buildings especially regarding water balance modifications, energy consumption, urban heat island effect and climate change mitigation strategies which focus on evaporation rather than greenhouse gas emissions. Since 1992, teaching and research activities at the Technical University of Berlin and the University of Applied Sciences in Neubrandenburg on developing the necessary skills and best practice in ecological construction.



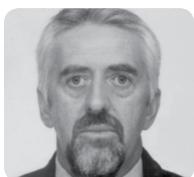
### FRANCISCO J. ESCOBEDO

Assistant Professor and Extension Specialist at the University of Florida, School of Forest Resources and Conservation. His research and extension work focuses on urban and community forest management, hurricane effects and ecosystem services. He has worked with the UFORE model (i-Tree Eco) for the last eight years and co-developed the i-Tree Storm hurricane adaptation. Dr. Escobedo worked for 13 years with the USDA Forest Service and holds a BS degree in Soil Science from New Mexico State University, a MS degree in Watershed Management from the University of Arizona and a Doctorate in Forest Resources Management, Environmental and Natural Resources Policy from State University of New York.



### PAOLO CORNELINI

Civil Engineer (1971) and Doctor of Natural Sciences (1986). Author of 70 publications in the field of environmental design and engineering nature. Co-author of Manual of environmental engineering of the Lazio Region and the Ministry of Environment. Vice President of A.I.P.I.N. (Associazione Italiana per la Ingegneria Naturalistica). Co-Lecturer in the Master of Science of Faculty of Agriculture of the University of Tuscia (Viterbo). Lecturer in more than 130 courses and seminars at universities, vocational training centers, regional administrations, professional associations.



### MAURICIO BALENSIEFER

Graduate Engineer in Forestry at the Federal University of Paraná. Post-graduate degree in Forestry at the Federal University of Parana. Professor at the Department of Forest Science of the Federal University of Parana, Coordinator of Recovery of Degraded Areas - since 1982. President of the Brazilian Society for Rehabilitation of Degraded Areas (SOBRADE). 16 years experience working in coordination, development, implementation and training in Environmental Restoration. Member of the Coordinating Board of the Iberoamerican Network and Caribbean Ecological Restoration, since 2007;

Representative of the International Society for Ecological Restoration, SER International for Latin America and the Caribbean (2007-2011).



### JOÃO FAISCA PEREIRA

M. Sc. degree in Hydraulics and Water Resources at Instituto Superior Técnico (IST), Technical University of Lisbon, Portugal. He got his Ph.D. in Engineering and Applied Science at the University of New Orleans in New Orleans, USA. He worked as a research assistant, in the Department of Civil Engineering and Architecture of IST, on fluvial and environmental hydraulics, hydrodynamic numerical and physical modeling. During his doctoral program, he worked as a research assistant at the Department of Civil and Environmental Engineering of the University of New Orleans. He is currently a Post-Doctoral Researcher at the Department of Civil and Environmental Engineering of the University of New Orleans.



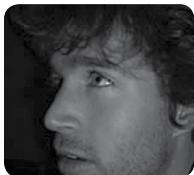
### FABRICIO J. SUTILI

M. Sc. Degree in forestry at the Federal University of Santa Maria (UFSM), and a PhD degree at the Universität für Bodenkultur (BOKU), Vienna, Austria - Department of Civil Engineering and Natural Hazards, Institute of Soil Bioengineering and Landscape Construction (IBLB). He is currently professor at the Federal University of Santa Maria (UFSM). Areas of Interest: Ecological Restoration, Soil Bioengineering and Watershed Management.



### HANS PETER RAUCH

Senior Lecturer, Post Doc in Soil-Bioengineering at the Universität für Bodenkultur (BOKU), Vienna - Austria. Expertise: soil bioengineering, semi-natural hydraulic engineering, water conservation, torrent and avalanche control.

**CLEMENS WEISSTEINER**

PhD-student at the Universität für Bodenkultur (BOKU), Vienna - Austria. Expertise: soil bioengineering and semi-natural river engineering.

**ANNA SERRA LLOBET**

Visiting scholar, University of California at Berkeley, Institute of Urban and Regional Development. Post-doctoral project: Floods, risk perception and land-use planning: a comparative study between the US and the EU (2011- ). Ph.D. Environmental Sciences, Autonomous University of Barcelona, Spain. M.Sc. Environmental Sciences, Autonomous University of Barcelona, Spain. Intern at the Directorate General for the Environment, European Commission, Brussels. Areas of Current Research: Flood risk assessment and management strategies focusing on Mediterranean rivers and climate change influences on extreme events, and vulnerability analyses of human societies living in flood prone areas.

**PILAR BARRAQUETA EGEA**

PhD in Natural Sciences from the University of Bremen, Germany (1981). Founding member of EKOS, Environmental Assessment and Research, environmental consultancy established in 1988. European managing director EECO Ecological Consulting SL since 1996. She works primarily in the environmental impact assessment of projects and strategic environmental assessment of land use and urban plans, as well as ecological restoration projects of various kinds. She belongs to several associations, such as: President of SALDROPO, Association for the study and protection of inland wetlands, Secretary of AEIP (Spanish Association of Landscape Engineering), Member of EFIB (European Federation of BioEngineering)

**DIOGO DE ABREU**

Director of the Center for Geographical Studies, University of Lisbon (CEG-UL). At present, with its team of 124 researchers, 43 of whom have PhDs, the CEG-UL is a reference in research and in the dissemination of geographical knowledge in Portugal.

According to European standards, it is considered to be a top quality research unit. Main interests: Modeling, Urban and Regional Planning (MOPT), Migration, Spaces and Societies.

**JOÃO CARLOS AZEVEDO**

President of the Portuguese Association for Landscape Ecology (APEP), and Professor at the Department of Environment and Natural Resources and Mountain Research Center (CIMO), based at the School of Agriculture of the Polytechnic Institute of Bragança, Ph.D., Forestry, Texas A&M University. Main Interests: Landscape ecology, sustainability in forested landscapes, nature conservation, sustainable short rotation forestry systems, modeling.

**FRANCISCO CASTRO REGO**

Professor at the Instituto Superior de Agronomia (ISA), Technical University of Lisbon, Portugal, and the Coordinator of the Baeta Neves Applied Ecology Research Center (CEABN), Lisbon. He received his PhD in Forestry, Wildlife and Range Management from the University of Idaho, USA. His research has been focused primarily on fire ecology and management. He is the international coordinator of the EU project Fire Paradox and the representative of Portugal in the Committee of the Forests, their Products and Services Domain (EU-COST). Dr. Rego was Director of the Forest Research Station in Lisbon (1996-2000), Director of the Portuguese Forest Service (2005-2007), and a member of the Directive Council of the European Forest Institute since 1998, as well as its Vice-Chairman, and Chairman (2002-2004).

**RUI CORTES**

Professor and Vice-Director of the Center for the Research and Technology of Agro-Environmental and Biological Sciences (CITAB), at UTAD, Vila Real, Portugal, Vice-president and Portuguese delegate at the Iberian Centre for River Restoration (CIREF),

President of the Audit Committee of APENA.

**JOSE MATOS SILVA**

Professor at the Faculty of Engineering, The Catholic University of Portugal (UCP), Lisbon, Portugal, President of APENA - the Portuguese Association for Soil- and Water-Bioengineering, President of Real 21 - a non-profit NGO dedicated to the restoration and preservation of Real River (1977 -). Member of EFIB - European Federation of Soil Bioengineering (2007 -), Counselor of the Tagus River Basin Management (2009 -). Author or co-author of more than 200 publications. Main Domains of Research: Hydrodynamics, River Hydraulics, Water Resources, Environmental Engineering, History of Hydraulics, Soil and Water-Bioengineering, Land Use Planning, Sustainable Development.

## ABSTRACTS OF THE ACCEPTED POSTERS

### 1.1.P.1.14

#### O PARQUE FLORESTAL DE MONSANTO

#### A SUA EVOLUÇÃO HISTÓRICA E UM CONTRIBUTO PARA O SEU PLANO DE GESTÃO

**Teresa Grilo<sup>1</sup>, Ana Luísa Soares<sup>2</sup>, Sónia Talhé Azambuja<sup>2</sup> e Cristina Gomes<sup>3</sup>**

<sup>1</sup> Aluna do Mestrado em Arquitetura Paisagista, Instituto Superior de Agronomia, Universidade Técnica de Lisboa, Tapada da Ajuda, 1349-017 Lisboa

<sup>2</sup> Centro de Ecologia Aplicada Professor Baeta Neves, Instituto Superior de Agronomia, Universidade Técnica de Lisboa, Tapada da Ajuda, 1349-017 Lisboa

<sup>3</sup> CML Divisão Gestão do Parque Florestal Monsanto, Estrada do Barcal, Monte das Perdizes, 1500-068 Lisboa

O Parque Florestal de Monsanto é o maior Parque da cidade de Lisboa ocupando uma área de cerca de 1000 ha. A história regista, já em 1868, a intenção de criar um parque florestal na descarnada serra de Monsanto. Mas só nos anos 30 se inicia a sua obra, pelo ministro das obras públicas, engenheiro Duarte Pacheco, e pelo arquiteto Keil do Amaral, altura em que se fizeram as expropriações, datando as primeiras plantações de meados dos anos 40. Nos anos 90 foram inaugurados espaços como o parque do Alto da Serafina e o Parque Ecológico. No início do século XXI a cidade de Lisboa regista um valor médio de área de espaços verdes de 9,1 m<sup>2</sup>/hab, se não incluirmos o Parque de Monsanto, e de 26,8 m<sup>2</sup>/hab se o incluirmos (Soares e Castel-Branco, 2007). Este facto justifica a importância atribuída ao tema em estudo que para além de uma análise biofísica e histórica do Parque, pretende retratar as alterações ao longo dos tempos, uma vez que tem sido alvo de grande pressão urbanística. Como objetivo final pretende contribuir com considerações relevantes para a gestão do Parque, tendo em consideração o Plano de Gestão Florestal aprovado



pela Autoridade Florestal Nacional em 2012 e a realização de inquéritos aos utilizadores do parque, delineando desta forma diretrizes que pretendem contribuir para a transposição do Plano para a prática de gestão deste território e promoção da sua componente ecológica, estética e social.

#### **Referência Bibliográfica:**

Soares, A.L. e Castel-Branco, C., 2007. As Árvores da Cidade de Lisboa. In SILVA, J.S. (Ed.), Floresta e Sociedade, uma história em comum. Público/FLAD/LPN, Lisboa. Pp: 289-334

**Palavras Chave:** Parque Florestal de Monsanto; Keil do Amaral; Biodiversidade; Sustentabilidade; Recreio

a resistência dessas plantas a movimentos de massa e ao escoamento superficial. Os resultados preliminares indicam *C. urucuana* como uma espécie promissora, ela foi a única a apresentar 100% de sobrevivência. Além disso, observações de campo indicam que as mudas, após o soterramento em um evento chuvoso, lançam raízes primárias em cerca de 7 dias, indicando que essa espécie parece ter rápido enraizamento e resistência ao soterramento. As estacas de *M. nigra* e mudas de *V. zizanioides* apresentaram, respectivamente, 60% e 40% de sobrevivência, resultados inferiores ao esperado. Experimentos em casa de vegetação também estão sendo conduzidos para elucidar melhor sobre o crescimento vegetativo de *C. urucuana*.

**Palavras chave:** Voçoroca, Croton urucuana, movimentos de massa, escoamento superficial.

#### **2.2.P.1.47**

#### **AVALIAÇÃO DO POTENCIAL DE ESPÉCIES VEGETAIS PARA RECUPERAÇÃO DE VOÇOROCAS – BACIA DO RIO MARACUJÁ (OURO PRETO - MG, SUDESTE BRASIL)**

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O presente estudo foi desenvolvido em uma voçoroca (54.300 m<sup>2</sup>) bastante ativa. Neste local foram delimitados dois canteiros experimentais, um deles se encontra em uma área plana e úmida (C1) e o outro se localiza em área mais seca e íngreme (C2). Em novembro/11, mudas e estacas de sete espécies foram plantadas com o objetivo de acompanhar sua sobrevivência e crescimento nesse ambiente. Mudas de *Croton urucuana*, *Eritrina falcata* e *Inga edulis*, espécies mais adaptadas a umidade, foram plantadas no C1. No C2 foram plantadas mudas de *Eremanthus erythropappus*, *Psidium guajava*, *Vetiveria zizanioides*, e estacas de *Morus nigra*. Cada canteiro foi dividido em quatro quadrantes, foram plantadas cinco mudas de cada espécie por quadrante, totalizando vinte mudas. Pretende-se retirar amostras do solo contendo o sistema radicular das plantas sobreviventes para a realização de ensaios de tensão ao cisalhamento e inderbitzen, obtendo dados referentes

#### **3.2.P.2.73**

#### **AVALIAÇÃO DE ENRAIZAMENTO ADVENTÍCIO E REBROTE DE ESTACAS DE *Schinus terebinthifolius Rad.* e *Leandra lacunosa Cogn.* PARA APPLICAÇÃO EM TÉCNICAS DE ENGENHARIA NATURAL.**

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Este estudo visou contribuir com informações sobre as características biotécnicas de duas espécies nativas de uma área no entorno de voçorocas da região de Ouro Preto, Minas Gerais (MG), Sudeste do Brasil, com ênfase para a aplicação em técnicas de engenharia natural de contenção e ou estabilização de processos erosivos. Para tanto avaliou-se o potencial de enraizamento adventício e rebrote de duas espécies de ampla ocorrência na área: 40 estacas de cada espécie, obtidas do caule, com 12 cm de comprimento e diâmetro variando de 1,2 a 2,2 cm para *Leandra lacunosa* e de 0,7 a 1,5 para *Schinus molle* foram coletadas e colocadas a 9 cm de profundidade em fitocelas contendo areia. Após 75 dias em casa de vegetação com controle microclimático, foram avaliados a taxa de sobrevivência, número, comprimento e diâmetro de raízes e

brotos das estacas. As estacas de *L. lacunosa* apresentaram 60% de sobrevivência, com uma média de 2,2 brotos com 2,1 cm de comprimento e 1,7 mm de diâmetro e um número médio de raízes de 0,1 com 0,2 cm de comprimento. As estacas de *S. molle* apresentaram 35% de sobrevida com uma média de 0,8 brotos com 1,7 cm de comprimento e 1,1 mm de diâmetro e um número médio de raízes de 0,8 com 0,6 cm de comprimento. Resultados do brotamento e enraizamento demonstraram que as espécies não são adequadas para aplicação em técnicas de engenharia natural de contenção e ou estabilização de processos erosivos.

**Palavras chaves:** voçorocas, engenharia natural, rebrote

#### 4.2.P.3.103

### A NEW METHODOLOGY FOR CALCULATING SLOPE STABILITY FACTORS INCLUDING PLANT ROOT ANCHORAGE EFFECTS

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In traditional stability factor formulae, behaviour of the different elements involved (soil and reinforcements) are characterized by its position. Thus, all terms included in the numerator are assumed to have similar stress-strain behaviour.

Differences in behaviour between reinforcement and soil may be due to several reasons (i.e. different stiffness, different strain-stress curves, and etcetera).

The use of the same value of FS for all the elements is not correct because of a lack of stress-strain compatibility. The soil and roots reach their peak resistance at a very different strain level.

For reinforced soil structures it is important that the reinforcement (the roots) be "compatible" with the soil. This means that the long term design strength of the reinforcement (root strength) should be achieved at a total strain level corresponding to a strain in the soil matching peak soil strength. This is a necessary step for achieving strain compatibility in slope stability formulae. This is a requirement of the proposed

methodology.

Slip surface development in soil is a progressive phenomenon, especially in reinforced soil where reinforcements delay the formation of a surface in their vicinity or it may be overstressed locally thus greatly deforming or creeping locally.

As strain progresses, the soil deforms and the resistance contribution by the soil progressively drops further, increase in root reinforcement load, further deformations, even more sections approaching the residual strength, and so on until the whole sliding surface is ruled by soil residual resistance.

By using limit equilibrium methods is not possible to find local failures within the slope. Local stability factors can be worked out by using finite element analysis.

In the proposed methodology the former limitations are overcome.

#### 5.2.P.4.49

### TEMPORAL EVOLUTION OF LIVE AND WOODY ELEMENTS IN A SOIL BIO-ENGINEERING STRUCTURE

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This study deals with surveys operated on crib walls in Tuscany, where *Salix alba* cuttings did not develop as expected from literature data.

After more than 10 years since realization and an initial very high survival rate, a few plants are yet alive among those put in place and the root strengthening is localized in the first 0.30 m just below the structure front face, while at further depth the detected root area ratio (R.A.R.) does not determine a noticeable increase in soil cohesion (Guastini et al., 2012).

Mortality curve in willow cuttings is comparable with growing

curve in *Alnus nigra* plants born in front of the structure, due to shading as failing cause.

Assessing quantitatively the residual strength of the timber elements and estimating their possible duration allow comparison with the time needed for a complete stabilisation of the para-natural succession. The two spans of time must be almost similar to avoid unexpected collapse of the frame or unacceptable costs for oversized structures.

Tests with *Resistograph* carried out on timber elements gives a good relationship between test results and density; through the non-destructive test it is possible to differentiate portions of wood with a noticeable residual strength from the decayed parts without any more load bearing capacity.

MOR value (flexural strength) of timber elements has been estimated on the basis of the effective section verified by the *Resistograph* (Guastini et al., 2012), and then confirmed through rupture in bending of the same elements (Wood Technology DEISTAF lab), by proving the non-destructive test utility.

#### **Reference**

Guastini, E., Preti, F., Togni, M. (2012) "Valutazione in opera della resistenza residua di strutture di ingegneria naturalistica", in *Quaderni di Idronomia Montana* n. 30, in press

contribuindo como suporte de uma intervenção ecologicamente sustentada e para o conhecimento, caracterização e valorização do local.

A área localiza-se no Superdistrito Olissiponense (COSTA et al., 1998) e apresenta um conjunto diversificado de situações, alternando espaços de diversidade biológica e paisagística com outros caracterizados por uma ocupação urbanística intensa. Globalmente, o local apresenta uma interface, arriba, duna com a foz do Rio Lizandro que o torna muito agradável e com elevado valor paisagístico.

O estudo foi composto por duas fases. A primeira corresponde à caracterização biofísica do local nas suas diversas variáveis e a segunda às propostas de gestão, mapas de zonamento e técnicas de engenharia natural aconselhadas.

Para a caracterização da vegetação recorreu-se ao método desenvolvido por BRAUN-BLANQUET (1932), posteriormente modificado por GÉHU & RIVAS-MARTÍNEZ (1980).

Apesar de nem todas as propostas terem sido realizadas, a intervenção no local não se encontra totalmente concluída, pelo que ainda existe a possibilidade que a intervenção venha a incorporar tais medidas em detrimento da intensa pressão urbanística e técnicas mais convencionais.

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**Palavras-chave:** Lizandro, Mafra, Arriba, Dunas, Engenharia Natural, Biofísica, Zonamento.

#### **6.3.P.1.48**

### **ESTUDO PRÉVIO E PROPOSTA DE INTERVENÇÃO NA PRAIA DA FOZ DO RIO LIZANDRO**

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No âmbito da implementação do Plano de Ordenamento da Orla Costeira Alcobaça-Mafra foi realizado em 2007 um protocolo entre a Câmara Municipal de Mafra e as empresas ConcepSys, Lda. e Ceregeiro - Arquitectura Paisagista, Lda.

O mesmo teve como objectivo primordial a caracterização da Praia da Foz do Rio Lizandro, nomeadamente através de uma descrição dos sistemas ecológicos fundamentais que a estruturam. Assim realizou-se uma carta de zonamento

## **INFLUÊNCIA DO COMPRIMENTO DE ESTACAS NO DESENVOLVIMENTO DE MUDAS DE *SEBASTIANIA SCHOTTIANA* (MÜLL. ARG.) MÜLL. ARG.**

Júnior Dewes; Robson Junior Bach; Charles Rodrigo Belmonte Maffra; Fabrício Jaques Sutili

*Sebastiania schottiana* (Müll. Arg.) Müll. Arg. (Euphorbiaceae), ocorre naturalmente no sul e sudeste Brasileiro, Uruguai e nordeste da Argentina. Esta espécie, apesar de sua já comprovada aptidão biotécnica, carece ainda de informações acerca de suas peculiaridades na reprodução vegetativa. O presente trabalho teve por objetivo avaliar a influência do comprimento de estacas no desenvolvimento de mudas da espécie.

O experimento foi conduzido em casa de vegetação, em delineamento inteiramente casualizado, constituído de quatro tratamentos com 26 repetições cada, sendo os mesmos compostos por diferentes comprimentos de estacas, onde: T1 = 15 cm; T2 = 12 cm; T3 = 9 cm; e T4 = 6 cm. Todas as estacas, as quais apresentaram em média 7,4 mm de diâmetro, foram inseridas até 2/3 de seu comprimento em recipientes de 180 cm<sup>3</sup> preenchidos com vermicomposto. Após 120 dias, decorridos a partir da data de plantio, das estacas sobreviventes foram avaliados parâmetros da parte aérea: nº brotos, massa seca e comprimento; do sistema radicular: nº de raízes e massa seca. Todos os parâmetros foram submetidos à comparação múltipla de médias (Tukey a 5%). Os resultados obtidos demonstraram que as estacas de 12 cm (T2), apresentaram os melhores resultados para todos os parâmetros avaliados, exceto para número de raízes, no qual não diferiu estatisticamente dos demais tratamentos.

Os resultados menos satisfatórios, basicamente foram apresentados por T4, ou seja, pelas estacas de menor comprimento (6 cm).

**Palavras-chave:** engenharia natural, bioengenharia de solos, estaquia

## **INFLUÊNCIA DO COMPRIMENTO DE ESTACAS NA TAXA DE SOBREVIVÊNCIA DE *SEBASTIANIA SCHOTTIANA* (MÜLL. ARG.) MÜLL. ARG.**

Robson Junior Bach; Júnior Dewes; Charles Rodrigo Belmonte Maffra; Fabrício Jaques Sutili

A propagação vegetativa é uma das principais alternativas de reprodução de plantas reófilas, estas largamente utilizadas em obras de engenharia natural. A engenharia natural é de aplicação relativamente recente no Brasil, em função disso, apresenta ainda grande anseio por informações básicas e de cunho prático.

O presente trabalho teve por objetivo avaliar a influência do comprimento de estacas na taxa de sobrevivência de *Sebastiania schottiana* (Müll. Arg.) Müll. Arg.. O experimento foi conduzido em casa de vegetação, em delineamento inteiramente casualizado, constituído de quatro tratamentos com 26 repetições cada, sendo os mesmos compostos basicamente por diferentes comprimentos de estacas, onde: T1 = 15 cm; T2 = 12 cm; T3 = 9 cm; e T4 = 6 cm.

Todas as estacas, as quais apresentaram em média 7,64 mm de diâmetro (CV=36%) foram inseridas até 2/3 de seu comprimento em recipiente de 170 cm<sup>3</sup> preenchidos com vermicomposto. Após 120 dias decorridos a partir do plantio, procedeu-se a avaliação do experimento. Os resultados obtidos demonstraram que T1 apresentou maior taxa de sobrevivência (68%) do que T2 (58%), T3 (60%) e T4 (47%) que não diferiram estatisticamente (teste Qui-quadrado ( <sup>2</sup>), com nível nominal de significância de 5%). Concluiu-se que, para esta espécie, existe um aumento na taxa de sobrevivência associado ao maior tamanho de estacas.

**Palavras-chave:** engenharia natural, bioengenharia de solos, estaquia, propagação vegetativa

## **INFLUÊNCIA DO COMPRIMENTO DE ESTACAS NA TAXA DE SOBREVIVÊNCIA E DESENVOLVIMENTO VEGETATIVO DE MUDAS DE *PHYLLANTHUS SELLOWIANUS* MÜLL. ARG. PROPAGADAS VEGETATIVAMENTE**

**Janaína Betto; Junior Joel Dewes; Fabricio Jaques Sutili**

*Phyllanthus sellowianus* é uma espécie nativa do sul da América, capaz de propagar-se vegetativamente e que apresenta aptidões biotécnicas já comprovadas, as quais viabilizam sua utilização em obras de engenharia natural, sobretudo em projetos relacionados a recuperação de margens fluviais. O objetivo deste estudo foi o de avaliar a influência do comprimento das estacas na taxa de sobrevivência de *P. sellowianus* na estação primaveril.

Conduziu-se o experimento em casa de vegetação em delineamento inteiramente casualizado, composto por quatro tratamentos com 26 repetições cada. O diâmetro médio das estacas era de 5 mm (CV=30%). Cada tratamento representa um comprimento de estaca: T1= 15 cm; T2 = 12 cm; T3 = 9 cm e T4 = 6 cm. Inseriu-se as estacas em 2/3 de seu comprimento em recipientes de 170 cm<sup>3</sup> preenchidos com substrato proveniente de vermicompostagem. Após 30, 60, 90 e 120 dias da implantação, procedeu-se as avaliações dos resultados. Indiferente ao tratamento, o percentual de pega foi sempre de 100%. Porém, entre 90 e 120 dias o crescimento em altura das mudas estagnou.

Os resultados obtidos demonstraram que os tratamentos não provocam diferença na taxa de sobrevivência desta espécie. Conclui-se também que a espécie é capaz de se desenvolver bem na estação primaveril em um período máximo de 90 dias para recipientes de 170 cm<sup>3</sup> preenchidos com vermicomposto. Entre 90 e 120 dias não houve mortalidade, no entanto devido às limitações nutricionais e de espaço para o crescimento radicular, o desenvolvimento das mudas cessou.

**Palavras-chave:** engenharia natural, RAD, restauração ecológica.

## **INFLUÊNCIA DE DIFERENTES SUBSTRATOS NO DESENVOLVIMENTO DE *SEBASTIANIA SCHOTTIANA* (MÜLL. ARG.). MÜLL. ARG. (EUPHORBIACEAE)**

**Junior Joel Dewes; Robson Junior Bach; Charles Rodrigo Belmonte Maffra; Fabrício Jaques Sutili**

*Sebastiania schottiana* (Müll. Arg.) Müll. Arg. (Euphorbiaceae), conhecida vulgarmente como sarandi-vermelho, ocorre naturalmente no sul do Brasil, Uruguai e nordeste da Argentina. Esta espécie, comprovadamente, apresenta aptidão biotécnica para restauração de margens de cursos de água, no entanto, as informações acerca de suas peculiaridades e exigências na reprodução vegetativa ainda são incipientes. Neste sentido, o presente estudo teve por objetivo avaliar a influência de diferentes substratos no desenvolvimento da espécie propagada vegetativamente.

O experimento foi conduzido em casa de vegetação no período primaveril, em delineamento inteiramente casualizado, constituído por três tratamentos com 18 repetições cada, sendo cada repetição composta por 3 estacas. Os tratamentos foram formados por diferentes substratos, onde: T1 = Areia; T2 = Comercial (vermiculita, casca de *Pinus* sp. e turfa) e T3 = Vermicomposto (resíduos orgânicos residenciais). Todas as estacas, as quais apresentaram 12 cm de comprimento e diâmetro médio de 8,20 mm, foram inseridas até 2/3 de seu comprimento em recipiente de 170 cm<sup>3</sup> preenchidos com os respectivos substratos. Após 120 dias, decorridos a partir da data de plantio, os seguintes parâmetros foram avaliados: taxa de sobrevivência, parte aérea (nº brotos, massa seca e comprimento) e sistema radicular (nº de raízes e massa seca). Os resultados obtidos demonstraram que o substrato de resíduos orgânicos residenciais (T3), apresentou os melhores resultados para a maioria dos parâmetros avaliados. Os resultados menos satisfatórios foram alternados entre T1 e T2, que não apresentaram diferenças estatísticas entre si (Tukey a 5%) para a maioria dos parâmetros.

**Palavras-chave:** engenharia natural, bioengenharia de solos, vegetação reófila, substratos

### 11.3.P.6.56

#### INFLUÊNCIA DO TEMPO DE ESTOCAGEM NA VIABILIDADE DE ESTACAS DE *PHYLLANTHUS SELLOWIANUS* MÜLL. ARG. (PHYLLANTHACEAE)

Júnior Dewes; Charles Rodrigo Belmonte Maffra; Elenice Broetto Weiler; Fabrício Jaques Sutili

*Phyllanthus sellowianus* Müll. Arg. (Phyllanthaceae), conhecida vulgarmente como sarandi-branco, comprovadamente, apresenta aptidão biotécnica para restauração de margens de cursos de água, no entanto, faltam informações acerca de suas peculiaridades na reprodução vegetativa. O presente estudo teve por objetivo avaliar a influência do tempo de estocagem do material de propagação na viabilidade vegetativa da espécie. O experimento foi conduzido em casa de vegetação, em delineamento inteiramente casualizado, utilizando-se 240 estacas com 30 cm de comprimento e diâmetro variando entre 6,5 e 7,5 mm, divididas em 8 tratamentos com 10 repetições cada, sendo cada repetição composta por 3 estacas, as quais foram plantadas em recipientes plásticos de 1L, previamente preenchidos com areia de granulometria média.

O plantio foi realizado em intervalos de 2 dias entre tratamentos, sendo o primeiro, implantado no mesmo dia da coleta de material vegetativo. Para os tratamentos, por convenção adotou-se: T0 = tempo zero; T2 = 2 dias, e assim por diante até quatorze dias. Ao término do experimento constatou-se que T0 e T2 apresentaram sobrevivência de 100% das estacas; T4, 80%; T6, 83%; T8, 57%; T10, 33%; T12, 13% e T14, 3%. De acordo com os resultados, o armazenamento de estacas da espécie estudada se mostra promissor até seis dias após a coleta, desde que mantidas em local arejado e abrigadas do sol. Recomenda-se a realização de novos estudos com estacas de diferentes diâmetros e comprimentos a fins de complementar as informações. Novos experimentos que verificassem diferentes formas de estocagem trariam informação complementares e bastante úteis do ponto de vista prático.

**Palavras-chave:** engenharia natural; bioengenharia de solos; vegetação reófila; taludes fluviais

### 12.3.P.7.57

#### PROPAGAÇÃO VEGETATIVA DE *PHYLLANTHUS SELLOWIANUS* MÜLL. ARG. E *TERMINALIA AUSTRALIS* CAMBESS

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O estudo teve como objetivo verificar a correlação do desenvolvimento da parte aérea com o sistema radicial das espécies *Terminalia australis* Cambess e *Phyllanthus sellowianus* Müll. Arg., o trabalho foi realizado no campus da Universidade Federal de Santa Maria (UFSM), no município de Frederico Westphalen (Sul do Brasil). O material vegetal, 40 estacas de cada espécie, com 30 cm de comprimento e com diâmetros de 5 a 11 mm e 15 a 28 mm foram obtidos de plantas localizadas à margem do Rio Pardinho e Rio Uruguai, municípios de Santa Cruz do Sul e Irai - RS, respectivamente.

A coleta dos dados foi realizada aos 60 e 120 dias após plantio. *T. australis*, apresentou aos 30 dias, 31 estacas vivas (77% de sobrevivência) ocorrendo decréscimo no número de brotações 60 dias após o plantio, com 19 estacas vivas (47% de sobrevivência) e ausência total de raízes nos dois momentos. Tanto aos 60 como aos 120 dias *P. sellowianus* apresentou 100% de pega e produção de 3 brotos em media por estaca. Todas as estacas apresentaram raiz, com massa seca média de 10g por planta aos 120 dias.

O desenvolvimento da parte aérea apresentou certa correlação com o desenvolvimento do sistema radicial, com destaque à relação massa seca de brotos/massa seca de raízes aos 60 dias ( $r^2= 55$ ) e 120 dias ( $r^2= 70$ ). Conclui-se que *T. australis* não apresentou resultados satisfatórios, por outro lado, a propagação vegetativa de *P. sellowianus* é possível e pode dar suporte a intervenções de engenharia natural, o desenvolvimento da sua porção aérea guarda certa correlação com o desenvolvimento do sistema radicular, o que tende a aumentar com o passar do tempo.

**Palavras-chave:** engenharia florestal, bioengenharia de solos, estaquia, biotécnicas

## ESTABILIZAÇÃO BIOTÉCNICA NO RIO PARDINHO MUNICÍPIO DE SANTA CRUZ DO SUL - RS - BRASIL

**Maikon André Herpich<sup>1</sup>; Suelen Camargo Cadoná<sup>1</sup>; Carla Lima Vasques<sup>2</sup>; Fabrício Jaques Sutili<sup>1</sup>**

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Este trabalho apresenta os resultados obtidos com a estabilização biotécnica em trecho de 80 m da margem esquerda do Rio Pardinho, a jusante de uma barragem de captação de água no município de Santa Cruz do Sul (Sul do Brasil). O trabalho compreendeu ações de caráter físico e vegetativo no final de fevereiro de 2010. Realizou-se um enrocamento vegetado utilizando-se blocos de basalto de 20 a 85 cm, combinados com plantio de mudas de *Calliandra brevipes* e *Salix humboldtiana*. Posteriormente foi instalada uma banqueta de arbustos com as espécies *Terminalia australis*, *Shinus molle*, *Schinus terebentifolia* e *Pouteria salicifolia*, sobre os arbustos, árvores de *S. humboldtiana* foram ancoradas ao talude com auxílio de pilotos de madeira e cabos de aço. Após aporte de solo uma linha de árvores foi ancorada sobre o talude produzindo um espião longitudinal. O ângulo superior (crista) do talude foi suavizado e foram plantadas estacas de *Phyllanthus sellowianus* e mudas de *C. brevipes*. Dentre as espécies propagadas vegetativamente, *P. sellowianus* e *S. humboldtiana* apresentaram resultados satisfatórios. As mudas utilizadas no enrocamento e na parte superior do talude estabeleceram-se com sucesso, a mortalidade um ano após o plantio foi inferior a 3%. Algumas árvores do espião longitudinal foram perdidas após forte precipitação, sem danos que comprometesssem a obra. De modo geral a intervenção realizada foi capaz de interromper o processo de desconfinamento local do talude fluvial e mantém a margem estável com a vegetação em franco desenvolvimento.

**Palavras-chave:** engenharia natural, bioengenharia de solos, enrocamento vegetado taludes fluviais

## EFICIÊNCIA DE UMA PAREDE KRAINER SIMPLES VEGETADA COM *HEDYCHIUM CORONARIUM* NO SUL DO BRASIL THE EFFECTIVEESS OF A CRIBWALL VEGETATED WITH *HEDYCHIUM CORONARIUM* IN THE SOUTH OF BRAZIL

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O desenvolvimento do Sul do Brasil tem gerado uma degradação ambiental nos rios das grandes cidades. A importância desse estudo se dá na apresentação de uma alternativa para a recuperação de taludes fluviais urbanos. Construiu-se uma parede Krainer simples vegetada com *Hedychium coronarium* J. König visando remodelar, estabilizar e recuperar ecologicamente um trecho de 20 metros de extensão de um curso de água.

A pesquisa analisou o desenvolvimento da vegetação na estrutura, e acompanhou a estabilidade do talude. Para isso, a parede foi dividida em três parcelas e as brotações contadas em três posições, sendo: T1 - linha d'água; T2 - meio da parede e T3 - alto do talude. Aos 3 meses da instalação do experimento chegou-se a um número de 11 brotos/metro linear na posição T1, 10 na posição T2 e 3 na posição T3, comprovando que essa espécie herbácea deve ser utilizada junto à linha d'água, em obras de engenharia natural que requerem plantas flexíveis e com rápida brotação.

Além disso, a espécie se propagou rapidamente recobrindo a face exposta da estrutura em um período de 150 dias, alcançando em média 1,5 metro de altura. A parede Krainer mostrou-se resistente a ação da enxurrada, uma vez que nenhum feixe foi removido.

A intervenção trabalhou solidariamente com o terreno, sendo que a partir do enleivamento do talude acima da estrutura o local foi inteiramente recuperado. Com a atuação do poder público e da iniciativa privada, moradores observaram uma ação inovadora e economicamente viável.



**Palavras chave:** bioengenharia de solos; recuperação ambiental; arroios urbanos.

The development in the South of Brazil has generated a environmental degradation on the rivers in larger towns and cities. The importance of this study is in the presentation of an alternative for restoring urban river bank slopes. A cribwall was built, which was vegetated with *Hedychium coronarium* J. Koenig, seeking to remodel, stabilize and ecologically recover a twenty-meter stretch of the water course. The research analyzed the vegetation development in the structure, and monitored the slope stability.

For this purpose, the cribwall was divided into three portions, and the buds were counted in three positions: T1 - at the water line; T2 - at the mid-point of the cribwall, and T3 - at the top of the slope. Three months after the start of the experiment, there were eleven buds/linear meter in position T1, ten in position T2 and three in position T3, demonstrating that this plant species should be used at the water line, in soil bioengineering works that require flexible plants that bud quickly.

Also, the species propagated quickly, recovering the exposed surface of the structure within a period of 150 days and reaching an average of 1.5 meters in height. The cribwall proved to be resistant to the action of spates, since no portion was removed by the water.

The intervention worked in harmony with the terrain, and from the earthworks of the slope above the structure upwards, the site was entirely covered. Through the initiative of the public authority and the private sector, the local residents benefited from an action that was innovative and economically feasible

**Key words:** soil bioengineering, environmental recovery, urban streams.

### 15.3.P.10.102

## OBRA DE ENGENHARIA NATURAL PARA REABILITAÇÃO DO REGATO DA CARVALHA E INTEGRAÇÃO PAISAGÍSTICA DA RIBEIRA DE GENDE, ARGONCILHE, PORTUGAL.

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A obra de Engenharia Natural (EN) para Reabilitação do Regato da Carvalha e Integração Paisagística da Passagem Ecológica da Ribeira de Gende, executada no âmbito da “CONCESSÃO DOURO LITORAL, A41 – Picoto (IC2) – Argoncilhe/Nó A32/A41, teve como objectivo a minimização dos impactes provocados pela construção da Autoestrada, através de soluções de EN que permitissem o controlo de erosão e restabelecimento da conectividade hidráulica e ecológica nos dois cursos de água.

A obra decorreu entre Outubro de 2010 e Março de 2011 e foi executada pelo Consórcio entre as empresas Teixeira Duarte Engenharia e Construções, S.A e Recolte, Recolha, Tratamento e Eliminação de Resíduos, S.A., com a empresa Wallmuro, lda como sub-empreiteiro. As soluções preconizadas em projecto careceram de algumas alterações na fase de obra, tendo sido construídos cerca de 300ml de Muro Vivo Simples, 100ml de Muro Vivo tipo Cribwall, aplicados 2000ml de Faxinas de *Salix atrocinerea*, 1500ml de Rolos de Pedra e de Biorolos de Fibra de Coco, 4500m<sup>2</sup> de Geomalha, 2400m<sup>2</sup> de Rede de Coco, executados 6800m<sup>2</sup> de Hidrossementeira e plantadas cerca de 2000 plantas de espécies características da flora local.

A monitorização das estruturas tem sido realizada através de registo fotográfico, sendo os resultados obtidos, reveladores das vantagens da implementação de soluções de EN, das quais se destacam, o restabelecimento da conectividade hidráulica entre os troços do Regato da Carvalha e da Ribeira de Gende, a estabilização e controlo de erosão nas margens e leito, o desenvolvimento da vegetação plantada e todos os benefícios estético-paisagísticos inerentes às intervenções.

**Palavras Chave:** Engenharia, Erosão, Reabilitação, Água

## ESTABILIZAÇÃO DE MARGEM FLUVIAL E RESTAURAÇÃO DE GALERIA RIPÍCOLA COM TÉCNICAS DE ENGENHARIA

### STREAMBANK STABILIZATION AND RIPARIAN RESTORATION USING SOIL BIOENGINEERING TECHNIQUES

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Este projecto consistiu na utilização de técnicas de engenharia natural para atingir alguns objectivos numa linha de água de baixa energia, estabilizando a margem fluvial, a qual se encontrava bastante degradada pela erosão causando a instabilidade do solo, bem com ao restabelecimento da vegetação ripícola, que era inexistente.

A primeira fase do projecto consistiu na limpeza e remoção de toda a vegetação infestante que dominava o local, bem como na posterior regularização do talude, eliminando os ravinamentos existentes.

Numa fase posterior, foi aplicada a técnica do enrocamento para proteger a base do talude que já se encontrava a ser escavada pela acção erosiva da água, e que punha em causa toda a estabilidade da margem fluvial. Para além do enrocamento, foi construída uma grade viva, a qual permitiu assegurar um efeito de armadura ao terreno, garantindo numa fase inicial a sua estabilidade.

Por fim, com o objectivo de promover o estabelecimento da galeria ripícola, recorreu-se à aplicação de outras técnicas de engenharia natural (estacaria viva, plantações, transplantes e hidrossementeira), as quais complementaram a grade viva.

Cinco anos após a sua implementação, a avaliação pós-obras apresenta resultados extremamente positivos, os quais garantem que os objectivos definidos inicialmente foram atingidos, já que a margem fluvial se encontra estabilizada e a galeria ripícola foi restabelecida.

This project consisted in the use of soil bioengineering techniques to achieve some key objectives in a low energy water course, by stabilization the river bank, which was quite degraded by erosion causing soil instability, as well to recover

the riparian vegetation that was inexistente.

The first phase of the project consisted in removing and cleaning all the invasive vegetation that dominated the local, as well as the subsequent regularization of the embankment, eliminating the existing gullies.

At a later stage, the technique of riprap was applied to protect the base of the slope that was already being excavated by the erosive action of the water, and that put into question the stability of the entire river bank. Apart from the riprap, a live slope grating was constructed, which allowed to ensure an effect of armature to the riverbank, guaranteeing in the initial phase, the stability of the slope.

Finally, in order to promote the establishment of the riparian gallery, some other soil bioengineering techniques were applied (live stakes, plantations, transplantations and hydroseeding), which complemented the live slope grating.

Five years after its implementation, a post operam evaluation shows us extremely positive results, which guarantee that the objectives initially proposed were achieved, since the river bank is stabilized and riparian gallery was restored.

#### Palavras-Chave /Keywords:

Estabilização de Solo, galeria ripícola, grade viva, enrocamento, estacaria viva, transplantes, plantações, hidrossementeira

Soil stabilization, riparian gallery, live slope grating, riprap, live stakes, plantations, transplantations, hydroseeding

## ECOLOGICAL RESTORATION OF GUINCHO-CRISMINA COASTAL SAND DUNE

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The dunes of Guincho-Crismina are a small portion of the dune complex Guincho-Oitavos located in the Natural Park of Sintra-Cascais (Portugal). It is a system subjected to strong anthropogenic pressures that led to its degradation and that, by its natural values, requires restoration and protection measures.

The habitat management actions aimed essentially to restore and manage the impacts on the dunes, through the installation of biophysical structures (which reduce the wind speed and promote the sand deposition), planting of characteristic species (*Elymus farctus* subsp. *boreo atlanticus* on embryo dune and *Ammophila arenaria* subsp. *arundinacea* on primary frontal dune) plus the removal of non-native species (*Acacia* spp., *Carpobrotus edulis* and *Cortaderia selloana*).

The biophysical structures were built with dry wicker (willow) and installed on the embryo dune and primary frontal dune in parallel tracks with a spacing of 9-12m between rows, perpendicular to the prevailing wind direction. After the period of greatest sand accumulation (summer), the plantation of dune species was performed.

The levels of sand accumulated by the biophysical structures were monitored through rulers distributed uniformly over the area of intervention. In the first 12 months it was registered about 1.7 m high of sand deposition behind the first row.

The planted vegetation is well established, although it had been necessary to replace some plants after this period of one year. The natural vegetation occurs spontaneously in the first three rows, with the presence of *E. farctus* subsp. *boreo-atlanticus* and *Cakile maritima*.

**Keywords:** Dune restoration, sand deposition, biophysical structures, vegetation.

## DEVELOPMENT OF AN EXTENSIVE GREEN ROOFS SYSTEM ADAPTED TO GALICIA. FIRST PHASE.

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10MRU004E is a project channeled into the development of a system of extensive green roofs adapted to Galicia, conscious of the numerous benefits that they generate and in keeping with the new? urban planning models. In the first phase the substrate characterization has been developed; we have selected a mixture of 60% (v/v) demolition waste (heavy and which presents low water retention and excessive aeration and porosity in large proportions), 30% (v/v) pine bark mixture and 10% compost (MSW). This selection shows some right physical characteristics, and although its %m.o. goes slightly beyond the recommendations (FLL,2008), it shouldn't be a limiting factor.

By other side, the native wild *Sedum* (Galicia) populations have been evaluated that showed an adequate growth habit, with rosette growth or decumbent stems according to species. Differences between different sites in the foliage, color and pubescence were observed in *S.hirsutum*, turning out interesting to obtain cultivars.

However, important differences in growth speed were observed, as between different species as between origins of the same species, all of them showed a plant cover speed equal or highly superior to the commercial one. Starting from a *S.hirsutum* (inland, Lugo) cutting with an initial cover of 27cm<sup>2</sup>, 264cm<sup>2</sup> may be reached after 134 days in peak conditions. This population and *S.album* reached greater cover values (AID);

*S.brevifolium*, *S.acre* and *S.rupreste* the lowest ones.

Differences in drought resistance between species were observed, but no between origins, recommending, in our test conditions, *S.hirsutum*, *S.brevifolium* and *S.album*.

The used methods to the cover quantification, the C2D-manual and the digital-image-analysis (AID), are useful, and, in general, are extremely correlated, although, C2D leads generally to an overestimation because doesn't assess irregular growth patterns. The correlation is minor in initial states and especially in more vertical plants (*S.rupreste*). In cases like these, we recommend AID, slower and more laborious but more precise regardless of the growth pattern.

The results suggest that is possible to define a system adapted for our conditions using a substratum from the recycling and native species. The following phase is developing and includes cuttings, turf and sowing studio of *S.brevifolium*, *S.album* and *S.anglicum* which are cultivated in the characterized substratum in a green roof.

**Keywords:** Green roofs, Sedum, substrate characterization, cover quantification, drought, resistance.

#### 19.7.P.1.65

#### AVALIAÇÃO DO CRESCIMENTO DO SISTEMA RADICULAR E DA PARTE AÉREA DE CANAVALIA ENSIFORMIS (L). DC

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*Canavalia ensiformis* L. DC (Fabaceae) popularmente conhecida como feijão-de-porco é uma planta rústica que pode desenvolver-se em solos de baixa fertilidade, podendo enriquecê-los pela fixação de nitrogênio. É indicada para adubação verde e controle de plantas invasoras. Considerando estas particularidades, é provável sua aptidão na recuperação de áreas degradadas, no entanto, o conhecimento acerca de sua arquitetura aérea e radicular é escasso. Neste trabalho teve-se o objetivo de avaliar o crescimento do sistema radicular e parte aérea da espécie, desenvolvendo-se em substrato de baixa fertilidade. Para tanto, 21 exemplares de *C. ensiformis* foram

plantados em recipientes plásticos com 80 litros de capacidade, preenchidos com areia de granulometria média. As plantas foram avaliadas em três momentos: 30, 60 e 90 dias do plantio. Aos 30 dias os espécimes avaliados apresentavam em média 15 raízes (primárias e secundárias) com 40 cm de comprimento na média e uma parte aérea de 11,6 cm de altura. Aos 60 dias o número de raízes cresceu para 25 e seu comprimento médio não aumentou significativamente (41 cm), já a altura das plantas passou a ser em média de 26,8 cm (crescimento de 131%). Aos 90 dias o sistema radicular desenvolveu-se pouco em número de raízes (27) bem como em comprimento médio (42 cm), novamente o principal acréscimo foi na porção aérea, que novamente dobrou sua altura média, passando a 53,1 cm. A espécie apresentou rápido crescimento inicial do sistema radicular e vigoroso desenvolvimento da porção aérea até os 90 dias, mesmo em substrato de baixa fertilidade. Ficou evidente seu potencial na recuperação de áreas degradadas, com destaque para locais de baixa fertilidade e onde se deseja um rápido recobrimento do solo.

**Palavras-chave:** RAD, sistema radicular.

#### 20.7.P.2.30

#### RECUPERATION OF A DEGRADED AREA: THE PAÚL DA GOUCHA ENVIRONMENTAL RESTORATION PROJECT (ALPIARÇA, PORTUGAL)

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The Paul da Goucha environmental restoration project started in January 2005 and comprised one of the several restoration initiatives developed through the Ripidurable Project. Paul da Goucha is located in the Tagus River Basin, in the Alpiarça municipality. It is an area that has been heavily influenced by human activity, being subject, among others, to the quarrying of aggregates. The ecosystem impacts of such activities made



restoration to pristine state impossible. Project objectives were to develop feeding, breeding and refuge habitats for aquatic birds, recovering the habitat, by fostering riparian vegetation colonization of the site, and to develop an environmental interpretation center to promote the importance of river habitat restoration and the role of these habitats as ecological corridors. The requalification project was drawn up over several discussions and meetings with a range of experts in order to meet the proposed objective. Project execution was divided in several tasks: preparatory work, soil re-profiling (which included the use of soil bioengineering techniques), construction of interpretation trails, planting, and construction of bird observatories. A range of activities for visitors was developed in such a way that they would not be exhausted in just one visit. Care was taken to make sure that the content of the activity program covered several disciplines of the National Curriculum. Three years after the end of the works, there is widespread colonization by natural pioneer riverine vegetation. Full project objectives will take some more years to be achieved, but the conditions are set for an even more successful outcome.

**Keywords:** Environmental restoration; degraded; ecosystem; Ripedurable Project; Paul da Goucha.

field, 3 specific Manuals, 18 Practical Books, a book on Soil Bio-Engineering Ethical Principles, a manual for high school students as well as many others publications and reports (available on the Lazio Region's website) have been published.

A great attention was dedicated to training through practical workshops, courses for public administration officers, and seminars in school.

The training practical workshops organised in protected areas were a laboratory where participants learnt the operational procedures and analysed the problems to be dealt with during the designing and execution of a soil bio-engineering work.

The training activity included a first theoretical phase, followed by field trips to the sites, and a practical phase to implement soil bio-engineering techniques to secure slopes and protect the borders of rivers.

Two nursery gardens dedicated to the production of local species were created in order to promote the supply of plants for soil defence interventions.

**Keywords:** Soil bio-engineering, training, parks and natural reserves

## 21.10.P.1.9

### LAZIO REGION (ITALY): BIO-ENGINEERING WORKSHOP

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Regione Lazio Direzione Ambiente Area Difesa del Suolo e Concessioni Demaniali

The objective of the Lazio Region is to incorporate the principles of Soil Bio-Engineering in the common project phase of a soil defence intervention, in order to reach the best technical results, i.e. reducing the hydraulic and soil instability while preserving as much as possible the natural and landscape heritage of the territory.

The actions of this complex initiative include an in-depth study of the subject matter and the training of officers, professionals, technical experts and students.

Thanks to the collaboration with Universities and experts in the

# ABSTRACTS OF THE ACCEPTED PAPERS

## 2.3.I.2.10

### ONE-DIMENSIONAL HYDRODYNAMIC AND SEDIMENT TRANSPORT MODELING OF THE LOWER MISSISSIPPI RIVER BELOW BELLE CHASSE

Pereira, Joao F.<sup>1</sup>; McCorquodale, J. Alex<sup>1</sup>; Georgiou, Ioannis Y.<sup>2</sup>; Meselhe, Ehab A.<sup>3</sup>; Allison, Mead.A.<sup>4</sup>; Holly, Forrest M.<sup>5</sup>

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#### 1.3.I.1.81 (INAUGURAL LECTURE)

#### WATER RESOURCES PLANNING WITH THE AID OF NUMERICAL MODELS

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Many global changes are occurring which put greater numbers of people at risk of flood related loss of life and property damage. The combined effects of climate change and the trend for development in flood prone areas makes it imperative to plan for these changes. Predictive tools are essential in the best allocation the massive funds that will be required to address these changes.

Water management is a key component of the planning that is needed. In this paper, the nature of the water and sediment processes that will be affected by global changes in climate and development will be discussed in terms of riverine and estuarine morphology.

The range of predictive tools will be outlined that can be applied to help quantify the impacts of climate changes and possible interventions to combat these changes. These tools include one dimensional model that can simulate decadal changes and two and three dimensional models that information on spatial impacts. The ongoing application of numerical models in the coastal planning in south Louisiana will be used to illustrate the paper.

The focus of this paper is the 1-D unsteady flow simulation of sand transport in the Lower Mississippi River (MR) from Belle Chasse (RM 74) to Main Pass (RM 4). The period of interest is the 2008 Spring Flood. The model is designed to assess and evaluate coastal restoration strategies. The existing conditions and one proposed diversions scenario (LPBF, 2008) are simulated.

Pereira *et al.* (2009) developed a 1-D HEC-RAS quasi-steady flow mobile-bed model for the main stem of the studied reach. Davis (2010) extended the model domain to include outflows and the delta with major distributaries, and applied for unsteady hydrodynamic simulations. CHARIMA, a 1-D unsteady flow hydrodynamic/sediment transport model is used to obtain information on the sand loads in the River and diversions.

For the existing conditions, a total outflow extraction of 53% of the Belle Chasse flow was obtained. The total sand load diverted amounted 30% of the peak suspended sand load at Belle Chasse. The proposed suite of diversions and channel modifications involves a total peak flow extraction in the reach of 80% of the upstream discharge. With this scenario, the model gave a sand load extraction for the whole reach of about 50% of the Belle Chasse input. These results suggest that it is possible to divert a significant portion of the River sand load during spring floods in reaches with relatively low energy; however,

the implementation of additional diversions will likely result in increased shoaling and reduction of sand load input to the wetlands.

**Keywords:** 1-D Numerical Modeling, Mobile-Bed, CHARIMA, Lower Mississippi River, River Diversions

model, Tarbert Landing (RM 306). The surge height at Baton Rouge (RM 228) was over 4m (13ft) for both Katrina and Gustav. Due to gauge failures very few records are available for Katrina to validate the model; however, the model is consistent with the limited Gustav data.

**Keywords:** 1-D Numerical Modeling, Storm Surge, Lower Mississippi River, HEC-RAS, Gulf of Mexico Hurricanes

### 3.3.C.1.21

#### ONE-DIMENSIONAL HYDRODYNAMIC MODELING OF STORM SURGES IN THE LOWER MISSISSIPPI RIVER

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To assess the impact of the storm surge during hurricanes Katrina and Gustav on the Lower Mississippi River (MR), three scenarios were simulated using the 1-D model HEC-RAS 4.1 in the Unsteady Flow Mode. The hydrodynamic simulations were performed from Tarbert Landing (RM 306) to the Gulf of Mexico. The periods evaluated were from 08/27/2005 to 08/30/2005 for Katrina and from 08/30/2008 to 09/02/2008 for Gustav.

The first case consisted on setting the downstream boundary conditions with stage values obtained from an ADCIRC storm surge model. For the second case, stage was set to sea level with no storm surge effect. Finally, stage values were set to typical tidal conditions. In all cases, flows at Tarbert Landing corresponding to the simulated periods were used as the upstream boundary conditions for the model.

It was observed for both hurricanes that many of the distributaries experienced reversed flow with the hurricane scenario. Flows were more impacted during Katrina than during Gustav. However, there were strong surges and large transient reductions in the River flow for both hurricanes. The upstream stage impact extended up to the upstream boundary of the

### 4.3.I.3.40

#### DESAFIOS CRIADOS POR UMA REQUALIFICAÇÃO FLUVIAL INTEGRADA: A RIBEIRA DE ODELOUCA

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Este caso de estudo, realizado na Ribeira de Odelouca (Bacia do Arade, Algarve), profundamente afetada pela degradação da vegetação ribeirinha, vulnerabilidade à erosão fluvial e impactes decorrentes da construção da Barragem de Odelouca, demonstra as linhas inovadoras, desde a conceção à intervenção, da proposta técnica, no sentido de propiciar a reabilitação das zonas ribeirinhas, mas também, de minimizar as alterações previstas no hidrodinamismo fluvial resultantes da exploração daquela barragem. Duma análise global de caracterização da bacia hidrográfica através de SIG, em termos de pressões, estado ecológico e biodiversidade, partiu-se para a definição concreta dos troços a reabilitar. Foram utilizadas técnicas de engenharia natural, quer para a consolidação dos taludes, quer para a eliminação do vasto canavial e recomposição da vegetação ripária. A intervenção foi integrada e multidisciplinar, englobando ainda a elaboração de modelos hidrodinâmicos (RIVER 2D) para a definição dos habitats mais adequados para as espécies piscícolas autóctones e quantificação do caudal ecológico. No entanto, por melhor que seja teoricamente o projeto, foi evidente alguma resistência dos proprietários, que impuseram alterações ao projecto inicial, pelo que é patente

a necessidade de ajudar a população e autoridades locais a adequarem as propostas técnicas e à realidade local e de se desenvolverem mecanismos amplos de participação desde a fase inicial.

**Palavras-chave:** requalificação fluvial; galerias ribeirinhas; hidrodinamismo; engenharia natural; formas de participação.

#### 5.1.C.1.68

### ESTUDO DA BACIA HIDROGRÁFICA DA LAGOA DE ÓBIDOS, PORTUGAL

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Os rios Real e Arnóia são afluentes da Lagoa de Óbidos, fazendo ambos parte das chamadas Ribeiras do Oeste, Portugal. Estas, como quaisquer outras, em Portugal, têm sido objecto de Planos de Bacia Hidrográfica, os quais visam identificar e prevenir problemas, de âmbito territorial, associados a uma gestão sustentável da água, para uma ou mais bacias hidrográficas. O primeiro Plano de Bacia Hidrográfica das Ribeiras do Oeste foi publicado em 2001, sob iniciativa da então Direcção Regional do Ambiente de Lisboa e Vale do Tejo, antes pois da transposição da Directiva-Quadro da Água para o direito português, concretizada em Dezembro de 2005, pela chamada Lei da Água, e regulamentação consequente. O segundo Plano das Bacias Hidrográficas das Ribeiras do Oeste iniciou-se em 2010, sob iniciativa da ARH-Tejo, estando presentemente na fase de consulta pública.

Este trabalho visa aprofundar o trabalho realizado, no que respeita ao caso particular da Lagoa de Óbidos, mais propriamente, rios Real e Arnóia. Não é possível, num plano único para todas as ribeiras do Oeste, ir ao pormenor, no caso de cada ribeira, em particular. Assim, às administrações e demais agentes locais deparam-se lacunas difíceis de colmatar e a que este trabalho procura responder. Ele inclui também uma comparação dos Planos da Bacia Hidrográfica dos anos de 2001 e 2011, documentando-se as mudanças verificadas neste intervalo de tempo, e as linhas directrizas para algumas

intervenções a efectuar em secções desta bacia hidrográfica, a título de demonstração. Para além da sua especificidade, este trabalho propõe uma metodologia para casos semelhantes, dentro e fora de Portugal.

Rivers Real and Arnóia are tributaries of Obidos Lagoon, and both part of the so-called West Streams, Portugal. Like any other river, in Portugal, they are subject to River Basin Plans, which are intended to identify and prevent problems of territorial scope, associated with the sustainable management of water for one or more watersheds.

The first River Basin Plan for the West Streams was published in 2001, under the initiative of then DRA-LVT. That was before transposing the Water Framework Directive into Portuguese law, implemented in December 2005, by the so-called Water Law and subsequent regulations. The second River Basin Plan for the West Streams began in 2010 under the initiative of ARH-Tejo, and is currently at the stage of public consultation.

This paper aims to deepen the work done in relation to the particular case of Óbidos Lagoon, more properly, rivers Real and Arnóia. It is not possible, in a single plan for all the West Streams, going into detail, for each stream, in particular. Thus, local and regional administrations and other agents are confronted with the difficulty to bridge gaps.

This paper attempts to give an answer to these type of problems. It also includes a comparison of the River Basin Plan for the years 2001 and 2011, documenting the changes observed in this time interval, and guidelines for interventions to be made in some sections of this river basin as a demonstration. In addition to its specificity, this paper proposes a methodology for similar cases, valid both inside and outside Portugal.

**Palavras Chave:** Bacia Hidrográfica, Plano de Bacia Hidrográfica, Engenharia Natural, Rio Real, Rio Arnóia, Lagoa de Óbidos, Ribeiras do Oeste.

### **6.3.I.4.80**

#### **ECOLOGICAL RESTORATION OF MODIFIED WATER BODIES IN CENTRAL EUROPE**

##### **Florin Florineth**

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The aim of revitalization is to restore the ecological functionality of a river.

Steps to that aim are the restoration of the

- lengthwise continuum (longitudinal cross-linking)
- crosswise continuum
- vertical continuum
- creation of pioneer habitats
- support of natural dynamics

Potential Measures are:

- modification of the stream course (meandering instead of elongated)
- modification of the cross-sectional area (expansion and/or restriction)
- modification of the riverbed and the bank (deconstruction of the hard bank protection and if necessary replacement by soil-bioengineering constructions)

In the lecture, some examples of successful revitalization projects from Austria, Switzerland and South Tyrol / Italy are introduced and discussed.

### **7.3.I.5.83**

#### **PESQUISA E APLICAÇÃO DA ENGENHARIA NATURAL PARA A RESTAURAÇÃO DE AMBIENTES FLUVIAIS NO BRASIL**

#### **RESEARCH AND APPLICATION OF SOIL BIOENGINEERING FOR THE RESTORATION OF FLUVIAL ENVIRONMENTS IN BRAZIL**

##### **Fabrício J. Sutili**

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Também no Brasil as técnicas de engenharia natural apresentam-se como alternativa na solução de uma série de problemas. Entretanto, não só esses modelos de intervenção são, no Brasil, pouco conhecidos, como carecesse de informações sobre as características técnicas da vegetação. Com intento de suprir parte dessa carência de informações a Universidade Federal de Santa Maria vem desenvolvendo pesquisas que investigam as propriedades vegetativo-mecânicas da vegetação ribeirinha e de encosta. Hoje, os conhecimentos reunidos garantem que a engenharia natural venha sendo aplicada com segurança na região sul do país. Uma série de informações já foram coletadas pelo Instituto de Pesquisas da Amazônia, gerando informações também para a região norte.

A Universidade Federal de Sergipe tem experimentado técnicas de engenharia natural para a estabilização das margens do Rio São Francisco na região nordeste do país. Atualmente esforços conjuntos entre as Universidades de Ouro Preto, Espírito Santo e Santa Maria pretendem trazer informações sobre a vegetação do bioma da Mata Atlântica na região sudeste. A lacuna de conhecimento quanto às características biotécnicas da vegetação ainda é grande e exige que as técnicas sejam utilizadas, em muitos lugares e situações, sob uma ótica conservadora, relegando a vegetação uma contribuição estrutural secundária. Com o desenvolver da pesquisa estamos tornando possível que os projetos possam cada vez mais contar com a vegetação como componente estrutural.

**Palavras-chave:** bioengenharia de solos, biotécnicas

In Brazil too, soil bioengineering techniques are presented as an alternative for resolving a series of problems. However,

not only is little known in Brazil about these models of intervention, but there is also a lack of information about the technical characteristics of the vegetation. To resolve this lack of information, the Universidade Federal de Santa Maria has been developing research that investigates the vegetative and mechanical properties of the riverbank and for slope protection vegetation. Today, the knowledge that has been gathered has led to soil engineering being properly applied in the South region of the country. A series of information was collected by the Instituto de Pesquisas da Amazônia (Research Institute of Amazônia), also generating information for the North region. The Universidade Federal de Sergipe has used techniques of soil engineering to stabilize the banks of the São Francisco river in the Northeast region of the country. Currently, joint efforts between the Universities of Ouro Preto, Espírito Santo and Santa Maria are underway, to bring information about the vegetation of the Mata Atlântica (Native Atlantic Forest) biome in the Southeast region. The gap in our knowledge of the biotechnical characteristics of the vegetation is still great, and requires the use of techniques, in many places and situations, from a perspective of conservation, consigning the vegetation a secondary structural contribution. With the development of research, we are making it possible for projects to increasingly include the vegetation as a structural component.

**Keywords:** soil bioengineering, biotechniques

### 8.3.I.6.26

#### RIVER MORPHOLOGICAL IMPACTS OF SOIL BIOENGINEERING LOW WATER STRUCTURES AT THE LIESING RIVER, VIENNA

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The Liesing River is a small scale river flowing 30 km through strongly populated regions in the south of Vienna and Lower Austria. From 2002 to 2006 several parts of the Liesing

river have been restored excluded a small section due to the reconstruction of a new railroad bridge. This 200 m long section was the subject of soil bioengineering implementation work during a student project in 2011. Due to hydraulic conditions soil bioengineering structures were required not to exceed low water level in order to minimize impacts during floods. Therefore only dead plant material was used in combination with different soil bioengineering measures.

In order to monitor first impacts on river morphology and define mesohabitats investigations on substrate, water depth and flow rate were conducted in two sections (6 x 6m) on a raster basis of 20 centimeters (900 data points). First section contained a dead rootstock and a branch layer and second section didn't contain any soil bioengineering measures. The sections were compared to each other in order to find any differences in flow patterns. After data collection, the results have been evaluated and classified.

Analysis has shown that many still water areas and differences in water depths have been found especially behind the branch layer, which make various living spaces available for a wide range of species. It arises that even in this short period after implementation of soil bioengineering measures (about eight months) there are already marginal differences between the two sections.

**Keywords:** river morphology, low water level, soil bioengineering measures

### 9.3.C.2.50

#### A UTILIZAÇÃO DE TÉCNICAS DE ENGENHARIA NATURAL E HIDRÁULICA FLUVIAL NA REQUALIFICAÇÃO DUM CURSO DE ÁGUA EM AMBIENTE URBANO. O CASO DA RIBEIRA DA CASTANHEIRA (RIO TINTO)

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A obra de restauro, estabilização e reabilitação da Ribeira da Castanheira, um afluente do Rio Tinto, na área envolvente ao segmento que circunda a nova estação do Metro, assume

especial importância atendendo à degradação física existente, associada com a elevada impermeabilização da respectiva bacia, conducente a incrementos substanciais e rápidos dos caudais de ponta de cheia.

Na intervenção são propostas técnicas que visam, além de dissipar a energia do curso de água, consolidar os taludes marginais, sujeitos a uma marcada erosão, com recurso a técnicas de Engenharia Natural e Hidráulica Fluvial, com vista à possível renaturalização do canal fluvial, criando assim condições para a posterior implantação da necessária cobertura vegetal, incluindo a manutenção duma zona húmida e o restabelecimento duma galeria ripícola de arbustivas e arbórea. As soluções a implementar contemplam a aplicação de gabiões rolo no contorno do curso de água, a aplicação de uma geomalha nos taludes laterais, colocada sobre uma hidromanta, dispondo de estacaria viva de salgueiros, e a criação de baías laterais de modo a que o canal adquira alguma meanderização potenciando a diversidade física.

A utilização de enrocamento com blocos de granito na face dos taludes que se encontre mais exposta a velocidades elevadas, e a colocação de açudes galgáveis nos sectores com maior energia, constituem soluções pontuais a implementar.

A margem direita, sobranceira á estação do Metro, com menor declividade e periodicamente inundada receberá, após a remoção dos RSUs existentes, uma plantação de amieiros e freixos em compasso, bem como de diversas helófitas.

**Palavras-chave:** Restauro, Requalificação Ambiental, Engenharia Natural, Hidráulica Fluvial.

### 10.3.I.7.70

## BIOENGINEERING FOR STREAMBANK STABILIZATION. REVISITING ALGIBRE RIVER PROJECT, PORTUGAL

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In Portuguese rural areas, river flow critical situations are often amplified by absence or mismanagement of the local water basin plan. On the other hand, intense local precipitation and negative changes in the land use may also generate disequilibria in the natural hydro-systems, with chronic soil erosion, flash floods, and degradation of the stream bank vegetation. With the arrival of hydraulic heavy equipment, traditional manual practices have been abandoned, namely, in the maintenance of stream banks, where they can be very useful tools, as complementary means to modern engineering techniques.

The INTERREG IIIB project PROGECO (Protection du territoire par le biais du génie écologique à l'échelle du bassin versant) was a European project aimed to test, in different sites of the Mediterranean basin, the efficiency and potentials of bioengineering in streambank stabilization and rehabilitation of natural habitats. The project had three case studies, including Algarve River basin, located in Algarve, with a total area of 221 km<sup>2</sup> - the Portuguese undertaking, which provided a contribution to: a) rehabilitation of a rural space; b) environmental awareness of local authorities and populations.

This project came to an end in 2006, and has proved to be of both local and national significance. Six years later, it is worth to assess what went right and what went wrong during PROGECO. This communication aims to retain lessons from that uncommon project, which may serve to improve the bioengineering methods and techniques available for streambank stabilization.

**Keywords:** Bioengineering, Streambank Stabilization, Algarve River, INTERREG, PROGECO

### 11.3.C.3.101

## FLUVIAL REHABILITATION: A STRATEGY FOR URBAN SUSTAINABLE DEVELOPMENT REVITALIZING URBAN STREAMS TO COPE WITH CLIMATE CHANGE AND SOCIAL DEMAND - LAJE STREAM, OEIRAS, LISBON METROPOLITAN AREA

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Fluvial Rehabilitation is currently the strategy for the recovery of urban river ecosystems and risk mitigation.

Water bodies, rivers and streams are key features in structuring landscape processes and functions, acting as a network of 'blue' corridors requiring the preservation of good ecological status or potential.

Green-blue infrastructure concept introduced a new paradigm on the Fluvial Rehabilitation strategy, from a traditional conservation planning tool, such as the green structure, or green-belt approach, to cope with climate change and involve societal needs and public participation.

In the Lisbon Metropolitan Area, urban development pressures impacts the ecologic and social value as environmental features. Climate change scenarios for this Mediterranean climate region points towards increased high peak flood risks, as well as low flows and dryer periods. So, stream restoration and management will need to cope with more frequent extreme events, as well as the need of restoring water quality, following Water Framework

Directive requirements.

The municipality of Oeiras, intends to face this challenge with the revitalization of the urban streams, looking for a planning process able to deal with these issues.

Following two international workshops that assessed opportunities and constraints for revitalizing these urban streams (Anderson *et al.*, 2005), a master plan for the Laje stream corridor is in progress.

It is the opportunity to shift from a more 'spatial planning' approach of a green structure to a more complex and multifunctional concept of blue-green infrastructure, aiming to focus on the urban streams as key elements to attempt the challenges of coping with climate change and with other environmental pressures, as well as with social demands.

**Keywords:** Fluvial Rehabilitation, Sustainable Development, Climate Change, Green Infrastructures, Urban Streams

### 12.3.C.4.59

## RESTAURACIÓN DE CAUCES EN LOS RÍOS AÑARBE Y ARAXES EN GIPUZKOA MEDIANTE INTRODUCCIÓN DE MADERA

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Los tramos guipuzcoanos de los ríos Añarbe y Araxes (País Vasco), forman parte de la red Natura 2000. Poseen aguas de buena calidad, y una aceptable vegetación de ribera y comunidad

piscícola. Sin embargo, la historia de usos, la existencia de infraestructuras paralelas y centrales hidroeléctricas, se traduce en una complejidad estructural deficiente para su cauce. Los estudios previos del hábitat fluvial muestran que apenas hay acumulaciones de grava que sirvan de frezaderos, y una escasez generalizada de pozas profundas que sirvan de refugio. La presencia de madera en el cauce está muy por debajo de las tasas deseables para este tipo de ríos.

Por otra parte, al igual que en otros ríos del entorno, desde finales de los 90 se constata un alarmante descenso en el reclutamiento de alevines de trucha común.

Con el objetivo de crear hábitats apropiados para la freza y para el desarrollo de los alevines, se han ejecutado durante 2008-2011 dos proyectos que han consistido en la introducción dentro del cauce de elementos de madera de diversa tipología (deflectores, árboles enteros y presas transversales), consiguiendo acumulaciones de gravas, aumentar rangos de velocidades y nuevas pozas-remansos.

Carácter experimental: se está realizando un riguroso programa de seguimiento con monitorización de parámetros abióticos (topografía, velocidad agua, composiciones granulométricas ...) y estabilidad de estructuras; y parámetros bióticos (frezaderos, densidad y biomasa de macroinvertebrados, cambios poblacionales piscícolas...). Los datos y conclusiones de este seguimiento se completarán este verano de 2012.

#### **Reportaje fotográfico:**

[https://picasaweb.google.com/114391075707941984043/Anarb e2008Araxes2011?authkey=Gv1sRgCPr\\_qo6g9tub6QE#](https://picasaweb.google.com/114391075707941984043/Anarb e2008Araxes2011?authkey=Gv1sRgCPr_qo6g9tub6QE#)

**Palabras Clave:** restauración, río, madera, ictiofauna.

#### **13.3.C.5.1**

### **TECHNIQUES AND EXPERIENCES OF SOIL BIO-ENGINEERING USING STEEL WIRE PRODUCTS**

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In a modern and natural approach the development of sound engineering practices combined with aesthetically pleasing and environmentally enhancing solutions requires the designers to understand how to design using “living” and “inert” materials together by best combining both types of materials.

The incorporation of vegetation through the use of soil bioengineering techniques improves the surface stability through the vegetative rooting system, however it is essential that the materials provide adequate strength and resistance during the initial stage of recovery of the project, as the vegetation will grow stronger over time.

The challenge for the most appropriate choice is to identify a system capable of providing the required shear resistance, (independently from the vegetation growth), and to be able to incorporate the most appropriate soil bioengineering treatment. To be successful, it is necessary to understand which products or systems are compatible with the related treatments.

Double twist steel wire products have shown an extraordinary capability for regeneration of the natural environment, since gabions and mattresses are filled with stones, soil and roots which eventually provide favourable developmental conditions. At the same time vegetation uses these structures as shelter during the initial growth phase, thus allowing these solutions to provide adequate structural and hydraulic performances even when plants are not fully developed yet.

The paper presents a series of technical solutions realised in different environmental conditions to highlight the new design approach entailing river protection works and soil stabilisation without altering the biological diversity of the site by assuring the stability of the works

**Keywords:** double twist steel wire, bank protection, vegetated gabions

## **BAIXO SABOR - MELHORIA DO HABITAT PISCÍCOLA DA RIBEIRA DA VILARIÇA COM RECURSO À ENGENHARIA NATURAL**

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O impacte da construção e exploração de grandes estruturas hidroelétricas nas comunidades piscícolas, consubstanciado pela fragmentação e perda de habitats que a descontinuidade daquelas estruturas impõe nos cursos de água, impede, normalmente, que as espécies realizem os ciclos de reprodução e disponham de locais de desova adequados.

No caso da barragem do Baixo Sabor (zona de Rede Natura 2000), recorreu-se a medidas de compensação para oferecer uma alternativa viável aos habitats perdidos, nomeadamente com a criação de zonas de desova de substituição. Para tal utilizou-se a ribeira da Vilariça, afluente da margem direita do rio Sabor, situada a jusante do empreendimento hidroelétrico.

O nível de degradação da ribeira da Vilariça determinou o desenvolvimento de um projeto de reabilitação e melhoria do habitat piscícola, orientado para a integridade ecológica daquele ecossistema. Após avaliação pericial, considerou-se prioritária a intervenção em três níveis: consolidação de taludes, eliminação de exóticas e medidas de incremento de habitat piscícola, nomeadamente: o aumento da heterogeneidade do substrato (blocos); construção de pequenos açudes galgáveis com o objetivo de albergar populações piscícolas autóctones com estruturas etárias equilibradas; construção de refúgios para a fauna piscícola; limpeza dos leitos de desova percolados (zonas de cascalheira e seixos rolados); construção/ implantação de estrutura de chamada/atração dos peixes situada na confluência da Ribeira da Vilariça com o Rio Sabor.

### **15.3.C.7.61**

## **HYDRAULIC AND FOREST WORKS WITH SOIL BIOENGINEERING TECHNIQUES FOR HYDROGEOLOGICAL RISK MITIGATION AND ENVIRONMENTAL RESTORATION IN CAMPANIA (ITALY)**

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The hydrogeological instability issue in Campania is really widespread because this territory has 504 municipalities out of 551 with a high hydrogeological instability (that is 91%), equal to approximately 19% of the entire region. For a correct management of the territory, it is fundamental a detailed maintenance that involves risk prevention but also a redevelopment of the landscape; the use of soil bioengineering techniques for hydraulic and forest works is increasing more and more because they are suitable to a positive and sustainable approach, and this is true both for hydrogeological risk mitigation and environmental redevelopment.

The A.I.P.I.N. division in Campania and the Provincia di Caserta are concerned with activities related to “Hydraulic and Forest settling with soil bioengineering techniques” with the assistance of forest workers. In accordance to this aim, a training course (whose technical-scientific direction was managed by the geologist G. Doronzo, and under the direction of the division manager, agronomist Ciro Costagliola) for 40 workers in the soil bioengineering field, has been made. Successively, the workers have carried out practical work which had already been studied during the course.

These works, produced in areas with a high propensity to hydrogeological instability, have been used to test the applications as well as the advantages of using some of the techniques reported in the D.P.G.R. n° 574/2002 of the Regione Campania, on the carrying out of soil bioengineering works in the territory of the Campania region. This is a consequence of projecting soil protection or environmental protection and



reclamation works which implies the recourse to bioengineering methods, in keeping with regulations. The report will be followed by a short description of the works concluded between 1998 and 2011 in Campania, relating in particular to those ones of hydraulic and forest engineering.

#### 16.3.C.8.72

### A ENGENHARIA NATURAL APLICADA AO RESTAURO DOS ECOSISTEMAS DUNARES DA FAIXA COSTEIRA DA HERDADE DA ABERTA NOVA

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A Herdade da Aberta Nova (HAN), localizada na Costa Alentejana próximo de Melides – Portugal, possui uma área de 450ha, donde se destaca uma faixa costeira de 1,6Km.

O Projecto Geral da Aberta Nova, mais que um projecto agrícola e florestal, é um projecto ecológico, económicos e social, que alia a investigação à divulgação. Assim pretende, por um lado recuperar e transformar de uma forma sustentável e económica, um terreno anteriormente ocupado por monocultura de Eucalipto, num terreno fértil e multifuncional, e assim aumentar de uma forma equilibrada a subsistência humana. Por outro lado e de modo complementar, associa a criação de um pólo "Espaço Aberta Nova" sendo um centro de investigação e divulgação e dinamizador de diversificadas actividades empreendedoras e inovadoras onde diversos grupos poderão desenvolver as suas actividades científicas.

Por intermédio de uma parceria tripartida (Aberta Nova, S.A., Universidade de Évora (UE) e APENA) concretiza-se um projecto exemplar que visa essencialmente a elaboração de um Plano de Gestão de Habitats Dunares e a sua aplicação por intermédio de Técnicas de Engenharia Natural.

Para a execução do Projecto de Engenharia Natural, pretende-

se através da instalação de um viveiro em espécies dunares fornecer todas as plantas necessárias, para além de promover a máxima reutilização dos materiais naturais resultantes da gestão florestalna construção da técnicas de Engenharia Natural bem como na construção dos equipamentos a instalar assim como a delimitação e melhoria dos acessos. Este projecto será também a fase de iniciação e divulgação do viveiro de espécies dunares, e mais uma porta para a divulgação da Engenharia Natural com workshops e cursos práticos, para além de nos possibilitar a produzir uma publicação conjunta.

**Palavras Chave:** Aberta Nova; Rede Natura, Engenharia Natural; Viveiro, Propagação, Dunas,

#### 17.8.I.1.92

### MANAGING URBAN AND PERIURBAN FORESTS AND THEIR ECOSYSTEM SERVICES AND DISSERVICES

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There is increasing literature on urban and periurban forests, their structure, soils, and ecosystem services and benefits they provide. However, biophysical and socioeconomic drivers of these ecosystem services vary within and between cities and urban forests can also yield site-specific "disservices" and tradeoffs. We present a case study from Miami-Dade USA that use field data, geospatial and mathematical models and spatial analyses to characterize urban forest structure, soils and ecosystem services. Relationships between land tenures and urban morphology with respect to urban forests, soils and invasive tree distribution will also be presented as will the use of urban forest structure data for quantifying ecosystem functions. For example, 1) older urbanized sites can be similar to natural forests in regards to certain soil nutrients, 2) Ecosystem services from urban trees can be cost-effective in mitigating carbon dioxide emissions and in mitigating tropical windstorm damage, But 3) invasive and exotic trees, shrubs and palms can contribute significantly to ecosystem services and can also yield ecosystem disservices. This approach will be presented using

a socio-ecological framework that facilitates the assessment of ecosystem structure and soils as the building blocks of urban forest ecosystem services that are of value to residents in cities of the world and also development of ecosystem service restoration indicators.

#### 18.8.C.1.16

### **NEW APPROACHES ON WATER MANAGEMENT INFRASTRUCTURE. LANDSCAPE AS THE FOUNDATION FOR CONTEMPORARY DESIGN STRATEGIES.**

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Recent urban climatic hazards, namely the ones associated with extreme weather events, are reassessing the basic foundation that infrastructures depend on (Costa, Sousa et al.). Considering water management in particular, it is clear today that centralized water infrastructure is not a precondition for human survival. Nevertheless, the usage of specialized engineering procedures, that address any problem related with water in a technical and mono-functional way, is still considered the best method to solve problems regarding water pollution and urban flood control - approaches that strengthen the separation from the natural hydraulic system (Saraiva, 2009), eliminating all special logics of the urban watershed.

The main hypothesis of this research considers that this is not an exclusive matter man-made autonomous systems, and that adequate solutions can be reached through the appropriation of urban infrastructure as urban landscape.

Frederick Law Olmsted, is often mentioned to be the first to put this matter into practice within his project for Boston's "Emerald Necklace" (Stokman, 2008). Simply put, he demonstrated that it is feasible to integrate complex ecologies of intermingling connections between natural, social and technical processes. Through this successful example and taking into account today's

treats on urban territories, namely the ones exacerbated by climate change, the pertinence of re-integrating the ecological principals in public space designs is reinforced (Deltacommissie, 2008).

This paper aims to contribute to this discussion through an analysis that explores the attributes inherent to Landscape, facilitating designers (architects and engineers), in their search for optimal design solutions.

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#### 19.8.C.2.63

### **PROYECTO DE MEJORA DEL ESPACIO FLUVIAL DEL RÍO TENAS EN SANTA EULÀLIA DE RONÇANA**

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El río Tenas a su paso por Santa Eulàlia de Ronçana ha padecido una presión antrópica importante que ha provocada una gran degradación del lecho del río. La canya americana (*Arundo donax*) aloctona e invasiva era la especie principal de la zona.

Con el objetivo de mejorar el río Tenas de forma integral, se redactó y ejecutó un proyecto en que se definieron unos

objetivos principales:

- Recuperar la estructura vegetal potencial con la finalidad de incrementar las comunidades de ribera y de fauna y flora.
- Eliminar aloctonas invasivas y otros impactos en el espacio fluvial.
- Estabilizar los márgenes minimizando los efectos de los procesos erosivos.
- Gestionar la vegetación de ribera existente para reducir la obstrucción con restos vegetales de las infraestructuras existentes en el río.
- La creación de nuevos hábitats con el reperfilado de taludes e incrementando el vínculo entre el bosque de ribera y el sistema acuático.
- Recuperar las fuentes existentes y crear nuevos espacios de parque situados cercanos al río.
- Mejora de la conectividad longitudinal del río.
- Establecer nuevos criterios de gestión del espacio fluvial con costes de mantenimiento bajos que permitan potenciar los valores ecológicos.

Se ha actuado en todo el tramo del río Tenes a su paso por el municipio, 4,8km llevando a cabo actuaciones de: eliminación de especies invasoras, retirada de escombros y deshechos, excavaciones y adaptaciones morfológicas de taludes, instalaciones de estructuras para estabilización y protección, actuaciones previas de revegetación y plantaciones de plantas acuáticas, arbustos y árboles.

Si nos centramos en el objetivo de estabilizar los márgenes, destacan las actuaciones ejecutadas en base a técnicas de bioingeniería. Se han utilizado 14 técnicas de bioingeniería distintas con la intención de resolver cada punto teniendo en cuenta sus singularidades. Para ello, se realizó un estudio previo de cada zona y una propuesta de las técnicas que optimizarían los objetivos específicos para cada tramo. En base a un estudio hidráulico del río se dimensionaron y calcularon cada una de las actuaciones. Las técnicas aplicadas son: rollada viva riparial, entramados de pared doble, enrejado vivo, fajina viva, geomalla permanente, herbazal estructurado en fibra, rollo vegetalizado hidromanta de algodón tipo Hydra CX2, manta orgánica, trenzado, i enfaginado con rollos de fibra.

**Palabras clave:** diversificación de hábitats, restauración ríos, bioingeniería, fuente, recarga de acuífero y protección de taludes.

## 20.9.C.1.28

### PERSPECTIVES ON “ECOLOGICAL NETWORKS” IN PORTUGAL: CONFRONTING EXPERTS’ VIEWS AND THE APPLICATION IN MUNICIPAL MASTER PLANS

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Land use change and land consumption have severely impacted natural systems, as the disruption of the water cycle, soil degradation or the loss of biodiversity. In this context greenways and ecological networks emerge as a promising approach to more sustainable land use planning. Since 1999 Portuguese law foresees the integration of ecological networks in spatial plans at multiple scales. It is at local level that the implementation of the “Estrutura Ecológica Municipal” (EEM) is most sensitive, as Municipal Master Plans (MMP) have an increased regulatory power on land use changes. Because only a few MMP have been revised during the last decade, there is still little experience on how to integrate the EEM.

It is the objective of this paper to gain a better understanding how the current status of integration of the EEM in MMP, by confronting expert views and its application in the already approved MMP in Portugal. Fifteen experts from different fields of expertise were interviewed regarding their views on the objective, potential, delimitation and further research needs. In parallel, all the approved MMP in Portugal were scrutinized in order to identify the way EEM are spatially delimited and regulated.

Results show that there is a wide range of integration strategies of EEM in MMP and that the majority of municipalities is still far away from acknowledging the purposes of EEM as stated by the experts. Ultimately, recommendations are put forward on what are the main shortcomings and challenges in promoting more efficient ecological networks at local level.

**Keywords:** Municipal Master Plans, ecological networks, land use planning.

## 21.4.I.1.85

### SOIL BIOENGINEERING AND LOCALLY APPROPRIATE USE OF PLANTS AS A WAY TO CONSERVE BIODIVERSITY

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## 22.2.I.1.90

### EROSION CONTROL OF MOUNTAIN ROCKY STREAMS BY MEANS OF SOIL BIOENGINEERING TECHNIQUES IN NORD- EAST ITALY

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Some cases of applications of soil bioengineering techniques realized in a mountain region of Nord east Italy are presented, on the basis of photographic documentation and technical schemes.

Erosion control of mountain rocky streams by means of living techniques is not simply because of big bed loads (debris flow) and often concrete constructions are necessary.

The author shows some cases of successful application of soil bioengineering on limit condition.

Many lining techniques have been employed: live wooden cribwalls embankments, array of blocks connected with ropes, embankments with green reinforced earth, green mattresses, vegetated rock wall, live brush mattresses, planting of willow cuttings and shrubs , hydroseeding, etc.

Testing of results after 10 years demonstrate important erosion control successful and a contemporaneous big implementation of biodiversity.



Fella river ante operam - 2002



Fella river post operam - 2011

## A STRATEGY FOR FINE SEDIMENT RETENTION WITH BIOENGINEERING WORKS IN ERODED TORRENTIAL CATCHMENTS IN A MOUNTAINOUS MEDITERRANEAN CLIMATE

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In eroded torrential catchments in mountainous and Mediterranean-type ecosystems, erosion can be responsible for high yields of fine sediment at the exit of catchments, which can cause different types of damage such as reservoir silting or ecological pollution. To avoid this sediment transport, low-cost rehabilitation actions such as involving bioengineering techniques within small gullies can be used to trap and retain eroded materials before they reach the catchment exit.

Based on current results of research carried out in the French Southern Alps, a specific strategy for such interventions is proposed, with rules for bioengineering structure use and methods for determining priority actions. This strategy for fine sediment retention with bioengineering works is currently being applied on eroded torrential catchments in the French Southern Alps, in a mountainous Mediterranean climate.

It has also been incorporated in a handbook of “soil bioengineering for torrential erosion control” (in French), which presents different kind of works and rules for their application in eroded torrential catchments.

## LIFE CYCLE ASSESSMENT – AN APPROACH TO OPTIMIZE MAINTENANCE CONSIDERING SOIL BIOENGINEERING STRUCTURES

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In eroded torrential catchments in mountainous and Mediterranean-type ecosystems, erosion can be responsible for high yields of fine sediment at the exit of catchments, which can cause

Soil bioengineering is a construction technique that uses biological components for hydraulic and civil engineering solutions. In general it pursues the same objectives as conventional civil engineering structures. A really essential distinction is the use of different construction materials. Nowadays there is a high demand on engineering solutions considering not only technical aspects but also ecological and aesthetic values. Soil bioengineering solutions are based on the application of living plants and other additives as construction materials to achieve technical as well as ecological oriented and natural landscape solutions.

The life cycle of this kind of “living” engineering structures is dominated by the dynamic development and capacity of plants and material properties of the additives. The efficiency of a soil bioengineering system has to be evaluated periodically. The assessment is depending on the field of application and the specific soil bioengineering function. The demand on soil bioengineering constructions of slope stabilization is completely different in comparison to those which are used for near nature river engineering. Different factors have to be taken into account from an engineering point of view related to process planning, design, construction, operation, monitoring and maintenance of soil bioengineering systems.

The paper gives an overview of the most relevant factors to assess soil bioengineering systems in different fields of

application. The functional capability will be analysed and discussed by the means of several examples at different levels of succession.

**Keywords:** Life Cycle Assessment, Soil Bioengineering Techniques, Maintenance;

has, considering the size range of objectives in technological, ecological, economic and aesthetic. In the Lower San Francisco River margin, slope stabilization is primarily the possibility of recovery of riparian vegetation, and as a consequence of erosion control, is expected to lower sedimentation rate translated in the form of decreased siltation of the river.

**Keywords:** Erosion, biotechniques, environmental degradation

## 25.2.I.4.104

### OVERVIEW OF THE USE OF SOIL BIOENGINEERING IN NORTHEASTERN BRAZIL

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This paper presents an overview of the use of soil bioengineering techniques or natural engineering used in the state of Sergipe, northeastern Brazil, showing the importance of the presence of living and inert elements on the physical protection of slopes against the effects of river bank erosion. This paper covers aspects ranging from the characterization of the biophysical systems and use (encompassing areas such as phytosociology, the geomorphology, geotechnical, erosion, or landslides, etc. This Approach is considered interdisciplinary techniques and methodologies that bring different kinds of its application to maximize synergies (the case of combined techniques of natural engineering where the combination of inert material allowing plants to install systems increasingly more efficient), with lower maintenance costs than the systems merely inert or merely based on the use of plants and adaptation to natural conditions of stability of the used materials. Our research actions in different places seek innovative techniques studies that consider material availability and local adaptation, as well as identification of species suitable to the ecological conditions the diversity of environments in northeastern Brazil

## 26.2.I.5.79

### ESTABILIZACIÓN DE LADERAS MEDIANTE LAS TÉCNICAS DE BIOINGENIERÍA. EJEMPLOS EN EL PAÍS VASCO

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La Bioingeniería, tal como viene definida por la EFIB, es la disciplina que estudia las propiedades técnicas y biológicas de las plantas vivas y su utilización, de manera aislada o en combinación con materiales inertes como son la piedra, la madera o el acero, como elementos de construcción en las obras de recuperación del entorno ambiental.

Debido a las condiciones orográficas, edáficas y climatológicas de Guipúzcoa, se producen frecuentes desprendimientos y deslizamientos. El servicio de Conservación de Carreteras del Departamento de Infraestructuras Viarias de la DF de Guipúzcoa solicitó una serie de informes técnicos en los que se presentan alternativas de utilización de técnicas de Bioingeniería a las soluciones de ingeniería tradicional, escogiendo para ello una serie de deslizamientos tipo.

En la comunicación se presentará la metodología llevada a cabo para el análisis de proyecto, común a los distintos casos, así como la ejecución de algunas de estas obras

**Palabras clave:** Bioingeniería, entramado, loricata, fajina , hidromanta

## **27.2.I.6.64**

### **CONTROL DE LA VEGETACIÓN Y ANÁLISIS ESTRUCTURAL DE LAS INTERVENCIONES DE BIOINGENIERÍA CONTROL OF VEGETATION AND STRUCTURAL ANALYSIS OF INTERVENTIONS OF SOIL-BIOENGINEERING**

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Se presentan los resultados del control post obra de la flora y vegetación espontánea de taludes de ferrocarril (1989-2002) y de la componente viva de las intervenciones de Bioingeniería (hidrosiembras, mantas, enrejado, y entrampado), construidos entre 1996 y 2005 en la Italia central mediterránea con el fin de evaluar el desarrollo de la vegetación y la capacidad colonizadora de las diferentes especies.

El estudio ha puesto de relieve la importe presencia de los árboles en las obras de bioingeniería cuya colonización se produjo espontáneamente a través de plantas de bosques cercanos a la obra.

El predominio de especies arbustivas nativas confirma el dinamismo de la serie de vegetación autóctona en detrimento de las especies exóticas invasoras como la Robinia pseudacacia.

Se confirmó el valor pionero de sauces en las estaciones no hidrófilas, con el desarrollo muy rápido y luego su posterior desaparición, dando paso a los arbustos autóctonos. El entrampado vivo Loricata (Cornelini 2009), del latín lorica, coraza, es una estructura mixta de acero y madera que utiliza una armadura metálica prefabricada como base de apoyo sobre el frente anterior de troncos horizontales de contención de la cuña de tierra revegetada con arbustos autóctonos y/o estacas.

Se proponen los primeros resultados de campo experimentales en los que, en colaboración con la Universidad Politécnica de Torino se han evaluado la resistencia estructural del entrampado Loricata al empuje de la tierra, con sensores y técnicas digitales analizadas mediante ordenador.

We present the results of the check post work of the spontaneous

flora and vegetation of the Railway embankments (1989-2002) and the live component of soil Bioengineering interventions (hydroseeding, blankets, living trellis and kreiner), built between 1996 and 2005 in Mediterranean area, in central Italy to evaluate the development of vegetation and colonizing ability of different species. The study has highlighted the amount of trees present in the structures of soil bioengineering, due to the colonization which occurred spontaneously through nearby forest.

The predominance of native shrub species confirms the dynamism of the series of native vegetation in detriment of invasive species such as Robinia pseudacacia.

We confirmed the value of the willows as plant pioneer in stations not hydrophilic, with a rapid development and then his subsequent disappearance, giving way to shrubs.

The loricata (Cornelini 2009), from the Latin lorica, armor, is a mixed structure of steel and wood using a prefabricated metal frame as a support base for a front of horizontal wood logs as contention of the wedge of land replanted with shrubs and/or stakes.

We propose the first experimental results in the field, in collaboration with the Polytechnic University of Turin that have evaluated the structural strength of the loricata to the earth pressure with digital sensors and analyzed by computer

## **28.2.C.1.4**

### **RAÍZES ADVENTÍCIAS AO LONGO DO CAULE DAS PLANTAS PARA A CONSOLIDAÇÃO DOS TALUDES**

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A Engenharia Natural (EN), desenvolvida na Europa Central depois da segunda guerra mundial e na Europa mediterrânea nos últimos vinte anos, está recentemente a desenvolver-se em Espanha e Portugal com grandes potencialidades de expansão, possibilitando que os desequilíbrios induzidos aos ecossistemas possam ser compensados. Para a estabilização e a consolidação das encostas, a EN pode utilizar, em lugar das estacas, árvores

e arbustos autóctones resistentes ao enterramento do caule e com facultade de rebentação radicular na sua extensão. Esta solução é particularmente útil por não sofrer insucessos, devidos aos longos períodos de estio mediterrânico, no primeiro ano de vida de uma obra de EN. Uma válida referência deste método de aplicação da EN são as obras realizadas no Parque Nacional do Vesúvio. As espécies pertencentes quer à flora da Europa central e centro meridional, quer à flora portuguesa e já utilizadas com êxito são em número limitado. Para ter um leque mais largo de espécies adequadas para a realização de obras de EN natural em Portugal, é necessário estender conhecimentos e experimentações, especialmente, realizar obras em solos mais secos que húmidos. Pretende-se com esta comunicação apresentar as bases lógicas e a primeira fase de implementação de um delineamento experimental em desenvolvimento, sobre o enraizamento caulinar adventício de quatro espécies lenhosas da flora de Portugal continental, em substrato de turfa e vermiculite e em solos de origem basáltica, calcária, xistosa e granítica.

**Palavras-chave:** engenharia natural, consolidação de taludes, propagação vegetativa, raízes adventícias, flora continental portuguesa.

#### 29.2.C.2.18

#### CONTROLO DE EROSÃO E INTEGRAÇÃO AMBIENTAL DA SCUT AÇORES

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A ilha de São Miguel situa-se 1.600 km a Oeste de Lisboa no arquipélago dos Açores. Ocupa uma superfície de 747 Km<sup>2</sup> e tem 140.000 habitantes.

A sua complicada orografia condicionou historicamente as relações entre as principais povoações da ilha o que tornava imperativa uma melhoria substancial da sua rede viária. Por este motivo, em 2006, foi adjudicada à empresa Ferrovial a melhoria, construção e concessão de vários tramos de via com o objetivo de melhorar a segurança e reduzir os tempos de deslocamento na ilha.

O acompanhamento ambiental das obras realizou-se segundo os preceitos estabelecidos no Relatório de Conformidade Ambiental (RECAPE), que, entre outros aspectos, exigia a observância da qualidade das águas, a integração paisagística e o controlo de erosão.

A revegetação foi condicionada pela desigual climatologia da ilha, o carácter vulcânico dos solos (pouco estruturados e carentes de matéria orgânica) e o declive dos taludes (1H:1V na generalidade).

Assinale-se que existem importantes variações entre as zonas Norte e Sul da ilha, dando lugar a distintos problemas de erosão. Sendo impossível o espalhamento de terra vegetal, estudaram-se diversas alternativas para revegetar os taludes e reduzir o risco de erosão, com custos razoáveis, visto a superfície a tratar superar os 600.000 m<sup>2</sup>. Finalmente optou-se pela utilização de hidromantas, com recurso a mulches hidráulicos de tipo FGM ou BFM de acordo com as características de cada talude.

A técnica utilizada foi um êxito, com extraordinários índices de cobertura que minimizaram os problemas de erosão e subsequentes custos de manutenção.

**Palavras chave:** Controlo de Erosão, Estabilização de Taludes, Revegetação, Hidromanta, Mulch.

#### 30.2.C.3.97

#### PROYECTO DE INTEGRACIÓN Y ESTABILIZACIÓN MEDIANTE BIOINGENIERÍA DE LOS TALUDES, BAJO EL VIADUCTO BASAGOITI, AP-1, EN ARETZABAleta, DIPUTACIÓN FORAL DE GIPUZKOA

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El pasado febrero se llevó a cabo la ejecución del proyecto de integración paisajística y estabilización de las zonas de sombra del viaducto Basagoiti, mediante técnicas de bioingeniería.

Las laderas bajo el viaducto, sus estribos y zonas de sombra de los tableros, presentan problemas ya que la revegetación no había tenido el éxito deseable. Varios puntos presentaban la tierra desnuda, síntomas de pérdida de suelo, erosión superficial, y escasa integración visual de este elemento.

La zona en cuestión, sobre relleno de limolitas procedente de la excavación de los túneles de la propia AP1, presenta una zonas poco vegetadas, debido en parte a que la ejecución de las hidrosiembra se realizó en época no idónea, y a la escasez de sustrato, y sobre todo a la dificultad añadida de la falta de humedad, al encontrarse bajo el sombra del viaducto. Se observaban también problemas de erosión superficial provocada por la escorrentía del agua y por la apertura de una pista forestal.

El proyecto de intervención tenía los siguientes objetivos:

- Mejorar la integración paisajística y visual del área bajo el viaducto Basagoiti
- Atajar los problemas actuales de erosión y pérdida de suelo
- Mejorar la estabilidad de los caminos que se han repuesto en la zona de sombra del viaducto
- Mejorar la funcionalidad y estabilidad del curso de agua que pasa bajo la estructura

Para ello, se han realizado las siguientes acciones:

- Estabilización de suelos mediante aplicación de hidromanta
- Tratamiento paisajístico de la plantación de bosque mixto existente
- Recogida, redireccionamiento, y aprovechamiento de las aguas pluviales para lograr tener la humedad necesario debajo de los viaductos, que permita la revegetación de estas superficies: para ello se construyeron pozos de retención de las aguas del drenaje longitudinal de los tableros, y toda una red de drenajes subsuperficiales a base de fajinas vivas y muertas. Estos drenajes, por un lado, evitan la erosión superficial que se estaba procediendo en esta zona, y además dirigen el agua de escorrentía hacia la zona de sombra de los tableros. Concretamente, hacia zanjas de plantación en las que se introdujo sustrato adecuado y plantas tapizantes, que poco a poco cubrirán estas superficies desnudas, muy difícilmente revegetables de otro modo.

Trascurrida la primera fase de brotación, en abril de este año se ha comprobado que el sistema de gestión de las aguas de escorrentía con bioingeniería está funcionando correctamente, y los arbustos tapizantes plantados en las zanjas "húmedas" bajo al sombra del viaducto han brotado de forma saludable, de manera que las perspectivas de evolución de la obra son muy buenas.

### 31.2.C.4.62

## BIOTECHNICAL SLOPE STABILIZATION MEASURES IN THE PHLEGRAEAN DISTRICT (ITALY)

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Landslides are, for the whole Italian territory, one of the main sources of geological hazards.

Campania stands among the first Italian regions as regards the landslide susceptibility and hazard, having suffered, in the period 1918-1996, consequences from more than 3000 events (about 10% of the total number).

This paper deals with a case-study located within the Campi Flegrei, one of the Campanian volcanic districts and, in particular, along the northern slope of the highest peak of the Phlegraean district, the Camaldoli hill (458 m a.s.l.). Here, loose pyroclastic terrains, ejected during several explosive eruptions, prevail in outcrop, resting over a bedrock made up of volcanic tuffs, the main of which is represented by the Neapolitan Yellow Tuff (12 ka). In the last decade, the Camaldoli hill has been repeatedly affected by rainfall-induced landslides which have represented a serious menace for the local population: in fact, some of the most densely inhabited districts of the city of Naples are located at the foot of the Camaldoli hill. Superficial soil slides (ranging from less than 0,5 to 1,5 m in depth), rarely evolving into channelized debris flows, are the dominating typology among mass movements, whose detachment area show slope angles ranging between 30° and 60°, while the mobilized volumes only occasionally exceed some hundred cubic meters.

Along the northern slope of the Camaldoli hill runs a road which

connects Naples with the towns of Quarto and Marano. This road has been often interested by small-scale mass movements, which induced local authorities to commit a project devoted to the landslide hazard mitigation. Among the remedial measures adopted a major role was assigned to biotechnical slope stabilization works, such as vegetated timber walls and geogrids, contour wattling, brush layering and others.

Having monitored the bioengineering works some years after their realization, some conclusive remarks are referred to their effectiveness in the landslide hazard mitigation.

**Keywords:** bioengineering techniques, landslides, loose pyroclastic, urban area

of landscape ecology in meeting or contributing to meet challenges in landscape management in Portugal. We analysed approaches and methods used to address the sustainable management of landscapes as well as particular case studies in forestry, fire hazard reduction, biodiversity conservation and regional planning where landscape ecology based knowledge or methods have been applied. Considering the insufficiency of applications in Portugal revealed by this work, we additionally present principles, guidelines and measures to be used in land management in general and within in the fields described above based upon the foundations and the practice in the field of landscape ecology, particularly in Portugal.

**Keywords:** landscape ecology, landscape management, principles and guidelines, Portugal

### 32.1.I.1.66

#### Landscape Ecology in Meeting Challenges in Land Management. The Case of Portugal

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The practice of planning and management at the landscape scale has increased over the year and in some fields, such as forestry, hydrology, or biodiversity conservation, the landscape approach is already a requirement. Management at this scale is a challenging task due to the complexity of the socio-economic-ecological systems under consideration but mostly due to the level of uncertainty of current and future drivers of change and their effects. Theoretical foundations and methods to support management of landscapes can be found within landscape ecology, an emerging science field in the 1990's and 2000's but now fully established despite the diversity of perspectives. In Portugal, landscape ecology has also emerged in the 1990's but applications in real world cases are infrequent.

The goal of this work was to analyse the role of the science

### 33.1.C.1.11

#### Artificial Intelligence – Bridging the Gaps in Soil Maps

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There is a growing need for digital soil maps at scales suitable for land management and regional planning. Soils modulate hydrological fluxes, regulate ecosystems and play an important role in mediating the impact of climate change. However, most European countries still lack complete soil map coverage at medium to large scales because soil surveys are very expensive and time consuming. Artificial Neural Networks (ANNs) are a means of quickly, cheaply and accurately predicting soils by learning rules that can be extended to unmapped areas. In this study two different types of ANNs (GeoSOM and Multi-layer Perceptron) and five sampling strategies are investigated in order to predict soil types across two catchments in Northern Portugal and implement, at a later stage, the best model to

complete the soil map coverage of Portugal at 1:100000, which currently stands at c. 45% of the country. Landscape variables that are also factors of soil formation, such as parameters derived from DEMs (altitude, slope, profile and plan curvatures, upslope area, dispersal area, wetness index and potential solar radiation), land use and lithology were combined with existing soil map data to train the ANNs. Results are largely concurrent between catchments, indicating that i) sampling has a higher impact on model accuracy and performance than model parameterisation, and ii) ANNs converge faster to a better solution if the sampling strategy takes into account that close neighbours are more likely to have similar soil types because the landscape variables most commonly used to predict soils are spatially autocorrelated.

**Keywords:** Soil Digital Mapping, Artificial Neural Networks, Geo-Self-Organizing Map, Multi-layer Perception Model, Sampling, Spatial Autocorrelation.

#### 34.1.C.2.25

### ESTRATÉGIAS DE GESTÃO E DE CONSERVAÇÃO PARA A PAISAGEM CULTURAL DE SINTRA, PATRIMÓNIO MUNDIAL

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A Paisagem Cultural de Sintra, classificada em 1995 pela UNESCO como Património Mundial, representa o testemunho de uma simbiose única entre Natureza e Homem.

O microclima específico e o coberto vegetal exuberante conferem à Serra de Sintra o espírito bucólico que promoveu, desde há muito, a sua ocupação por diferentes culturas: Dos vestígios neolíticos, a Suntria medieval; Dos conventos e ermitérios espalhados pela solidão da Serra, ao estabelecimento da Corte e nobres nas suas quintas de recreio, dispostas harmoniosamente por entre maciços graníticos e a luxuriante

vegetação introduzida. A Paisagem de Sintra construiu-se sob influências artísticas e literárias, sendo hoje inclusivamente considerada como uma referência na expressão do Romantismo, que influenciou a Europa do séc. XIX.

Esta unidade, integrando ainda o Parque Natural de Sintra-Cascais, caracteriza-se, assim, como uma área rica, mas de grande sensibilidade. A actual pressão urbanística e constantes ameaças à preservação deste conjunto, nomeadamente à área florestal, motivam o desenvolvimento da investigação de Mestrado, na busca da conservação desta paisagem de inigualável valor, assim como na sua manutenção como património classificado pela UNESCO. Como principal objectivo, pretende-se o desenvolvimento de uma proposta de Plano de Gestão desta Paisagem Cultural, procurando-se um desenvolvimento coerente do ponto de vista turístico e económico, delinear estratégias que visem a protecção do conjunto através da potencialização das suas mais-valias, no ensino e transmissão de conhecimento às populações com base à preservação, assegurando a manutenção e perpetuidade da sua identidade, valores ecológicos e biodiversidade da Serra, permitindo a vivência em pleno deste património.

**Palavras-Chave:** Sintra, Paisagem Cultural, Património, Romantismo

#### 35.1.C.3.30

### LAND CONSOLIDATION PROJECTS - AN INSTRUMENT FOR CONSERVATION OF NATURAL ECOSYSTEMS IN RURAL LANDSCAPE

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Land consolidation is an instrument for rural development, commonly interpreted to be only the simple reallocation of parcels to remove effects of fragmentation, in order to improve agricultural productivity. However, this land management reform has broader effects in rural areas. More than just improve the agriculture income, this instrument allows to "redesigning" rural landscapes in which the interests of agriculture, landscape,

sustainability and nature conservation can be balanced. This paper describes examples of Portugal's land consolidation projects and their influence in rural ecosystems conservation and sustainable use of land resources.

**Keywords:** land consolidation, sustainable rural land management, agriculture, ecosystems conservation.

### 36.1.I.2.88

#### A NEW PARADIGM IN SUSTAINABLE LAND USE

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The global change in land use and its impact on the hydrology reduces evaporation and precipitation rates and releases heat. On the global scale we lose a vegetated area of 800 km<sup>2</sup> daily. 350 km<sup>2</sup> are lost due to deforestation, 150 km<sup>2</sup> daily in urbanisation and 300 km<sup>2</sup> due to desertification. The loss of vegetation and fertile soils causes a huge impact on the hydrological cycle and releases sensible heat. The discussions on global climate change neglect the importance of vegetation and photosynthesis and result in a mix up of cause and effect of global warming. The increase in drought is the cause of global warming, not the effect of rising temperatures.

If we take the basics of ecology into account, we need to follow a paradigm shift in sustainable land use towards evaporation of water. Not a single drop of rainwater may leave land surfaces simply being funnelled into sewer systems. Urban areas need to implement vegetation in and on buildings, rainwater harvesting and waste water recycling for irrigation and adiabatic cooling. Agricultural land should cover as much biomass the whole year round as possible. The increase of biomass production for thermal use ("bio"fuels, wood pellets) to avoid CO2 emissions mainly causes the opposite than intended. A reduction in evaporation due to unsustainable land use starting with deforestation results in global warming. The amount of CO2 in the atmosphere is not dominated by anthropogenic green house

gas emissions, it is an indicator for the photosynthesis process. Vegetation defining the relation between CO2 and oxygen in the air as well dominates the development in temperatures due to evaporation. Therefore, CO2 is an indicator and not cause for the global warming. It is a pity how much time and engagement of people has been wasted in thousands of meetings on global warming worldwide.

### 37.1.C.4.32

#### GRAZED LANDSCAPES: THE IMPORTANCE OF LAND MANAGEMENT

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The Mediterranean Basin is a rich and diverse mosaic of landscapes (Bugalho *et al.*, 2011). However, intensive management of pastures has been responsible for soil degradation in areas of high desertification risk. Within this context, we analyzed two alternative management practices at grazed areas that can improve soil condition: the replacement of natural and improved pastures by sown biodiverse permanent pastures rich in legumes (SBPRL) and the use of no tillage for shrub control.

SBPRL are an innovation from the Engineering of Biodiversity that allows an increase of the soil organic matter (SOM) and consequent carbon sequestration, improvement of soil nutrient availability and water holding capacity, increasing plant productivity and reducing surface runoff (Teixeira *et al.*, 2011).

Grazed areas are frequently subject to tillage techniques as a way to control the vegetation. Tillage destroys soil structure and mineralizes SOM (Pereira et al., 2010). But, if not controlled, there is an increase in fire risk. The consequences of fire and soil loss for soil water holding capability and biodiversity are particularly dramatic in the Mediterranean areas. The shift from vegetation control with tillage systems to no tillage ones also allows an increase in soil organic matter, with the same benefits. Nowadays there are about 85000 ha of SBPPRL in Portugal, a significant percentage supported by the Portuguese Carbon Fund in the context of the Kyoto Protocol. Recently, the Portuguese Carbon Fund has demonstrated interest in remunerating the farmers willing to control shrub encroachment at pastures through the use of non-invasive techniques.

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**Keywords:** pastures, shrubland, tillage, soil organic matter.

#### **38.1.C.5.42**

### **PROPOSTA DE RECUPERAÇÃO AMBIENTAL DA MICROBACIA DO CÓRREGO QUILOMBOLAS, NO SEMI-ÁRIDO BRASILEIRO**

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A micro-bacia do córrego Quilombolas, localizada no semi-árido brasileiro (pluviometria média anual de 980 mm), tem apresentado redução progressiva da descarga média dos rios nas últimas décadas associada ao desmatamento e erosão. Geologicamente, afloram na área duas formações distintas: Salinas (solos delgados, argilosos, com baixa permeabilidade); e São Domingos (arenitos, com solos espessos e permeáveis). A partir de trabalhos de campo, fotografias aéreas e imagens de satélite, 4 domínios com características ambientais distintas foram delimitados: D1: sobre a formação São Domingos, nas cabeceiras da microbacia, com vegetação bem preservada, principal zona de recarga. D2, 3 e 4: sobre a formação Salinas, apresentam 26 grotas. O D2 constitui área com nascentes perenes e mata nativa. O D3 engloba regiões com relevo mais íngreme e desmatamento freqüente. O D4 constitui trecho de relevo mais suave, com a presença maior número de alvéolos e planícies de inundação. Para reverter os processos de degradação e recuperar o fluxo de base do córrego são sugeridas as seguintes intervenções: criação de legal protected area, abrangendo a região dos domínios 1 e 2, construção de diques de retenção nos canais das grotas, para reter os sedimentos e parte da água da chuva, aliada ao replantio e o cercamento de áreas desmatadas nas encostas íngremes, objetivando a recomposição da vegetação natural; construção de diques de derivação associados a estruturas para recarga artificial, como, tanques de infiltração nas áreas mais planas do D4. Além disso, educação ambiental, pois as intervenções não terão sucesso sem o engajamento da população local.

**Palavras-Chave:** Bacia Hidrográfica, Gestão de Territórios; Áreas degradadas

### **39.1.C.6.67**

#### **SUSTAINABILITY AND RESILIENCE IN WATERSHED MANAGEMENT. THE CASE STUDY OF ALENQUER REGION, PORTUGAL**

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This paper proposes a set of sustainable management measures to increase watershed resilience in Alenquer region (Portugal) where serious urban flooding incidents have occurred over the last decades. The focus of the study are flood protection best practices drawing mainly on international sustainable guidelines from the EU and UN.

The paper is organized in four sections. The first section includes a brief discussion on the meaning of sustainable resilience in a watershed management context. The second section introduces the case study area, data and methods. The methodology includes a biophysical analysis of Alenquer region watershed, a diagnosis of the main sustainability flooding hazards, both natural and human induced, and the proposal of mitigation, structural and non-structural measures, supported by a spatial decision support system. The third section discusses a set of potential measures to increase watershed resilience in Alenquer region, including those related to flood protection, land management, and governance mechanisms. Finally, the paper draws conclusions for the application of sustainable resilience measures more widely in watershed management, and the technical and governance challenges involved in the sector.

**Keywords:** Sustainable Resilience, Watershed Management, Alenquer

### **40.8.I.2.74**

#### **RESURRECTING RIVERS IN CITIES**

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While larger rivers often structure urban form, smaller rivers and streams have commonly been erased from cities, relegated to concrete box culverts or underground pipes. This was understandable when these streams were highly polluted, but with recent improvements in water quality, even small urban streams can provide quality public space and opportunities for children and adults to interact with nature. 'Daylighting' – taking buried streams out of pipes and allowing them to flow once again as flowing, surface streams – is an increasingly popular restoration activity in cities.

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### **41.10.I.1.96**

#### **DEVOLVIENDO LAS AVENIDAS A LAS LLANURAS DE INUNDACIÓN. ESPACIO PARA EL RÍO Y LAS IMPLICACIONES DE LAS POLÍTICAS EUROPEAS**

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## TÉCNICAS DE RECUPERAÇÃO DE ÁREAS DEGRADADAS - A EXPERIÊNCIA NO BRASIL

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A recuperação de áreas degradadas tem sido adotada pela maioria dos países do mundo e esta iniciativa é motivada por imposição legal que rege cada país ou pela conscientização dos povos sobre sua importância para a vida futura na terra.

As práticas ou técnicas para se atingir os objetivos tem evoluído graças aos avanços das pesquisas nesta área. Essas técnicas ou procedimentos apresentam diferenças marcantes em razão dos diferentes biomas ou ecossistemas objeto dessas ações. Nas florestas tropicais por exemplo, caracterizadas por uma variada biodiversidade, depara-se com grandes dificuldades quando o objetivo é restaurar a área degradada até por conta da ausência de áreas de referência que possam fornecer subsídios e conhecimentos sobre a estrutura, composição e função do ecossistema que foi alterado, objetivos a atingir quando se busca a restauração.

O Brasil é um país tropical que se destaca por possuir um terço das florestas tropicais remanescentes 10% das espécies de plantas ou animais existentes. Essa enorme biodiversidade exige estudos e técnicas apuradas para se buscar a restauração ecológica, devido sua alta complexidade. Às vezes os ecossistemas são manejados atendendo a preceitos culturais que variam de região para região mas que contribuem para sua reabilitação e num aspecto mais amplo, para sua restauração.

Esta apresentação relata a evolução das práticas e pesquisas desenvolvidas no Brasil na medida em que mostra programas de recuperação de áreas degradadas executados por diferentes atividades como a agropecuária, obras como a abertura de estradas e urbanização e em especial, a mineração. Esta atividade merece destaque visto que contribui com o tema sob dois aspectos: de um lado, degradando intensamente os ambientes onde atua e, de outro, contribuindo com recursos e pesquisas na busca de soluções para a recuperação ambiental.

## RESTAURACIÓN DE LA RIERA DE VALLVIDRERA EN BARCELONA. EJEMPLO DE INTERVENCIÓN A NIVEL DE CUENCA

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La riera de Vallvidrera (Barcelona) combina zonas con una presión urbanística importante y con una frecuentación de usuarios elevada, con otras que mantienen un buen estado natural, situadas dentro del Parque de Collserola. La presencia de especies invasoras y vertidos no controlados hacia disminuir de manera considerable la calidad del curso fluvial en un proceso gradual de degradación.

Los principales objetivos del proyecto, cuyo promotor ha sido el Consorcio del Parque de Collserola, han sido el de eliminar completamente las especies vegetales invasoras, eliminar o mitigar (en el caso de no ser posible la eliminación) impactos existentes y diversificar los hábitats para la fauna, siempre teniendo como premisa el afrontar las obras de ejecución empezando desde la cabecera y avanzando hasta la desembocadura, considerando el curso fluvial como sistema holístico, dónde toda actuación afecta aguas arriba y sobretodo aguas abajo.

A través de campañas consecutivas entre 2008-2012 se ha eliminado el *Arundo donax* y el *Ailanthus altissima* a lo largo de los 12.1km de la riera (excepto el tramo final que transcurre por zona urbana) afectando a una superficie total de 4500m<sup>2</sup>. Se ha protegido con técnicas de bioingeniería aquellos tramos con problemáticas concretas que afectaban a infraestructuras y se ha dejado que el río evolucione libremente en el resto. Para potenciar la fauna y flora se han construido balsas temporales vegetadas con carrizo y enea que realizan la función de filtro

verde.

La eliminación de especies invasoras y la recuperación del bosque de ribera desde la cabecera en la riera de Vallvidrera ha implicado, entre otras cosas, que la recolonización de espacios por *Arundo donax* haya sido prácticamente nula, hecho que implica una reducción importante del mantenimiento respecto a otras obras de restauración. Así mismo, ha permitido la creación de un banco de semillas en cabecera, que junto con la propia dinámica del río, actúa como agente recuperador del bosque de ribera aguas abajo.

**Palabras clave:** especies invasoras, bosque de ribera, gestión a nivel de cuenca, conectividad longitudinal.

#### 44.7.I.2.5

### LA ANTIGUA TURBERA DE SALDROPO: 22 AÑOS DE RENATURALIZACIÓN

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El Humedal de Saldropo es un enclave ubicado en el Parque Natural de Gorbeia (Vizcaya-País Vasco) y es fruto de una intervención acometida a principios de los 90 encaminada a la regeneración natural de un enclave singular que desapareció a finales de los 80: la Turbera de Saldropo. Ésta constituía el único caso de turbera alta del País Vasco. A pesar de su extraordinario interés, la explotación de su turba la destruyó totalmente. De ella sólo quedó una ceja de turba -hoy prácticamente invisible- como testigo de un extraordinario depósito de turba de más de tres metros de espesor.

Tras el cese de las actividades extractivas, el área quedó convertida en un solar de terrenos removidos, sin vegetación, con depresiones con agua y montículos de tierra y escombros

que hizo que la recuperación del ecosistema de turbera fuera ya prácticamente imposible. En aras a su restauración, se acometió un proyecto destinado a renaturalizar el enclave, vallando el enclave para evitar la entrada del ganado, favoreciendo la revegetación espontánea, aumentando las láminas de agua e intentando convertir el área en un humedal que remedara en la medida de lo posible el ecosistema de tipo pantanoso o palustre perdido con la desaparición de la turbera. Las primeras intervenciones en este sentido datan de 1990. En poco tiempo, el crecimiento vegetal disimuló la agresión sufrida y se desarrolló un sistema húmedo mixto, con áreas secas, estanques y un bosque pantanoso. En cada uno de estos ambientes, fruto de un proceso de sucesión ecológica, se produjo un paulatino enriquecimiento en especies. Ya en 1997, el humedal acogía a múltiples especies de invertebrados, a 9 especies de anfibios y cuatro de reptiles, 37 de mamíferos y en torno a medio centenar de aves merodeaban en la zona, muchas durante el paso migratorio. Destacaba la presencia del zampullín común (*Tachybaptus ruficollis*), gallineta común (*Gallinula chloropus*) y rascón (*Rallus aquaticus*). Después de más de 20 años, el área presenta un aspecto boscoso donde predominan los salgueros negros (*Salix atrocinerea*).

Desde el principio, se ha venido realizando el seguimiento y el estudio de su evolución por parte de miembros de la asociación "Saldropo" y se han acometido proyectos de educación ambiental. Aquí se muestra el inicio del proceso de regeneración natural y paisajística hasta la actualidad, destacando que han vuelto a aparecer especies propias de turbera (*Sphagnum auriculatum*) y se ha favorecido la aparición de un hábitat poco frecuente en el País Vasco, como son los bosques de suelo encharcado. Como aspectos negativos debe señalarse la aparición de alguna especie invasora (como *Baccharis halimifolia*) y la proliferación de exóticas, como el ciprés de Lawson (*Chamaecyparis lawsoniana*).

**Palabras clave:** sucesión natural, restauración ecológica, turberas, Saldropo

## **CRUSHED LATERITE: AN ALTERNATIVE FOR PLANT GROWTH IN POST MINING BAUXITE AREAS**

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Although the use of topsoil has been suggested in restoration processes of areas degraded by mining operations, this is not always possible, especially in sites lacking topsoil. In these cases, new substrates, preferably those locally available should be tested. In an abandoned bauxite mine in Southeastern Brazil, small patches of native vegetation spontaneously established in shallow depressions over weathered laterite, suggesting that granulometric reduction may have facilitated the establishment of plants. To test this hypothesis, blocks of laterite collected in the area were crushed to simulate texture observed in the vegetation patches. Topsoil collected in a preserved ferruginous site located near to the mined area was also used as a substrate in which *Eremanthus erythropappus* seedlings, a native woody species, were grown. Seedlings were cultivated without fertilizers in these two substrates and also directly over the exposed and uncrushed laterite. The species proved to be very promising for the revegetation, showing a high survival rate in all substrates. Higher annual growth rates and higher final biomass values were observed in topsoil, but the granulometric reduction of laterite doubled plant growth rate in comparison to the exposed laterite. This result was likely due to the increased availability of essential nutrients to plants and to the improvement in physical conditions for root growth and functioning. Moreover, the species accumulated high concentrations of Al and Fe in roots, suggesting that *E. erythropappus* is a good candidate for phytostabilization projects in bauxite and iron mines.

**Keywords:** *Eremanthus erythropappus*, bauxite, phytostabilization, metal-rich substrates, crushed laterite

## **WASTEWATER REUSE IN THE IRRIGATION OF KENAF (*HIBISCUS CANNABINUS* L.) AS A STRATEGY FOR COMBATING DESERTIFICATION**

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Combating desertification, a marked problem in countries located in the Mediterranean regions, such as Portugal, Spain and Italy, encompasses the management of water resources and the conservation of soil properties, factors that are essential to ensure food and water security and biological and landscape diversity. Moreover, it was considered that erosion and water availability are of greater concern in these regions. Establishing vegetation on land may be advantageous insofar as it reduces the air dispersion and run-off, provides coverage to wildlife, introduce improvements in the visual impact, and can even allow an economically viable crop. Kenaf is a short day, annual, herbaceous plant producing high quality cellulose. As a high yielding plant, is also a potential energy crop, presenting a high water and nutrient use efficiency with a deep, dense and extensive root system, important for the restoration of soil fertility and to slow down wind and water erosion. In this context, the purpose of this work was to test the use of wastewater containing different concentrations of ammonium ion in the irrigation of kenaf (*Hibiscus cannabinus* L.). The plant was shown specificity on the wastewater phytodepuration, especially at 15 mg dm<sup>-3</sup> (NH<sub>4</sub>), being capable to incorporate biomass at an average rate of 15.1 g day<sup>-1</sup> m<sup>-2</sup>, suitable for the production of bioenergy and fiber, involving low water consumption, in a short time period and with low production costs. In this framework the use of kenaf irrigated with wastewater as a strategy for combating desertification is modeled and discussed.

**Key-words:** Kenaf; Bioenergy production; Phytodepuration; Soil restoration; Desertification.



#### **47.6.C.1.98**

#### **HIDROBOX - SISTEMA URBANO DE DRENAJE SOSTENIBLE (S.U.D.S.)**

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Existen graves problemas de inundaciones en zonas urbanas y degradación de los cauces naturales como consecuencia de una extensa impermeabilización de dichas zonas y de un deterioro del sistema de recolección de aguas pluviales. Esto conlleva una deficiencia grave en la gestión de escorrentías, tanto en su volumen como en su calidad.

El sistema Hidrobox conforma una geoestructura de polipropileno de alta resistencia que permite ejecutar elementos de captación pluvial, acumulación y transporte subterráneo de forma modular y sencilla. El objetivo es reproducir el ciclo hidrológico natural previo a la urbanización o actuación humana.

Los principales beneficios obtenidos al aplicar los SUDS son:

- Reducir los volúmenes de caudal punta procedentes de zonas urbanizadas.
- Minimizar el coste de las infraestructuras de drenaje favoreciendo el paisaje
- Mejorar la calidad de las aguas receptoras, favoreciendo los procesos naturales de depuración e impidiendo las cargas contaminantes.
- Retener los excesos de nutrientes (nitratos, fosfatos,...) que producen el fenómeno de crecimiento incontrolado de la vegetación que hace disminuir la presencia de oxígeno en las aguas y consiguiente muerte de seres vivos.
- Integrar el tratamiento de las aguas de lluvia en el paisaje
- Permitir aprovechar el agua captada para otros usos (riego, limpieza de calles).

**Palabras clave:** Drenaje Urbano, SUDS, Hidrobox, Hidrostank, Agua Pluvial.

#### **48.10.I.2.87**

#### **RIVER RESTORATION IN SWITZERLAND, NEW FEDERAL POLICY, SAMPLES FROM DIFFERENT CANTONS**

**Rolf Studer**

Dep. Chairman of EFIB (European Federation for Soil Bioengineering), Vice-President of Verein für Ingenieurbiologie, Switzerland.

#### **49.10.C.1.31**

#### **BIOENGINEERING TECHNOLOGY FOR THE RESTORATION OF RIVER SYSTEMS IN THE SORRAIA'S VALLEY**

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In the Sorraia's valley is fundamental to establish principles and rules - Best Management Practices - to ensure an effective response of the dominant hydrological and hydraulic conditions of river systems to the pressures of landuse and occupation.

For this Mediterranean climatic region, with nonpermanent water courses but also with semiarid characteristics, the effective application of measures to mitigate the problems related to water resources management must be done by prevention and structural measures, resulting from the application of integrated methodologies, namely, hydrological, hydraulic, biophysical, ecological, landscape, and social, in agreement with the landuse planning objectives.

In this framework and with the aim of an integrated management of the land, a series of interventions, aimed to the restoration of the hydrographic network of the Sorraia's

valley were recommended by the application of bioengineering technologies which seek for interdisciplinary integration and coordination in promoting, stimulating and accelerating the restoration process and taking in account the particular nature of each watercourse.

Major changes in the dynamics of the watercourses are clearly noticeable in Sorraia's river catchment with strong influence on the morphology and stability of riverbeds and in the riparian vegetation. The proposed type of solutions, in the study context, besides promoting the improvement of aquatic and riparian ecosystems, create conditions for the establishment of an ecologic river "continuum", contribute to the restoration of the drainage system and sets of a framework of solutions, namely, reduction of flooding discharges, restoration of riverbeds, delimitation of flooding areas, bank conservation, or other structural measures.

**Keywords:** requalification, river system, bioengineering

#### 50.2.C.3.41

### UTILIZAÇÃO DE ESTACAS DE ESPÉCIES XERÓFILAS DA FLORA CONTINENTAL PORTUGUESA EM OBRAS DE ENGENHARIA NATURAL

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Apresentam-se os resultados sobre o enraizamento de estacas de espécies xerófilas possivelmente adequadas ao uso das técnicas de engenharia natural (EN) para a estabilização de vertentes.

Estas espécies foram selecionadas de um grupo de plantas *candidatas*, obtidas de um trabalho de revisão do conhecimento sobre esta matéria, que aguarda publicação, consideradas provavelmente adequadas á obras de EN e que necessitam de

ser testada essa sua adequação.

Os critérios de selecção foram: (i) uma ampla distribuição geográfica e a (ii) presença de escassas referências bibliográficas sobre a sua capacidade de propagação vegetativa.

Os testes foram realizados a partir de estacas recolhidas de plantas mãe na região de Lisboa e instaladas na Tapada da Ajuda (Centro de Ecologia Aplicada, Professor Baeta Neves, Instituto Superior de Agronomia, CEABN - ISA), Lisboa. Para cada espécie foram testadas estacas de diferentes diâmetros, colocadas verticalmente em tabuleiros e em posição sub-horizontal num talude. Após 2 meses, parte da amostra inicial foi retirada para análise, através de um delineamento experimental, do seu desenvolvimento radicular com recurso ao programa informático "GiA Roots". A outra parte foi transplantada com intuito de se proceder ao estudo da viabilidade do seu transplante.

Os bons resultados obtidos com este estudo permitem disponibilizar novos materiais construtivos, - vivos - para obras de EN em Portugal continental, contribuindo estas espécies para a aceleração da colonização vegetal em solos pobres, locais áridos e de condições edáficas não-óptimas.

**Palavras-chave:** engenharia natural, espécies xerófilas, flora portuguesa, estacas, enraizamento, propagação vegetativa.

#### 51.2.C.4.43

### THE POTENTIAL OF NATIVE SPECIES FOR GULLIES REVEGETATION IN BRAZIL

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The lack of information about seed germination rate, survival and growth of native species has justified the use of exotic plants

to gullies revegetation in Brazil. However, exotic species don't always have good results, especially on oligotrophic soils and in areas subject to highly seasonal climate, leading to revegetation failure or significantly increasing the need for cultivation care. In this study, seedlings and clumps of native cerrado (Brazilian savanna) species, *Cratylia argentea* and *Echinolaena inflexa*, and of the exotic grass *Vetiveria zizanioides*, were transferred to a gully colluvium in Ouro Preto, Brazil, where they remained during the dry season without application of fertilizers or irrigation. In randomized block design, plots of 1 x 1 m received four planting treatments, clumps of *E. inflexa* or *V. zizanioides*, and clumps of these grasses intercropped with the legume *C. argentea*. All grasses and 73% of the legume seedlings survived. As expected, the green cover of *E. inflexa* decreased throughout the dry season, however, showing regrowth after the first rains. Leaf area of *V. zizanioides* remained active and grew significantly in the period. *Cratylia argentea* showed high rates of germination and growth, however, nodulation occurred only in two individuals. Thus, there was no influence of the legume on grasses growth. After field experiments, twenty non-deformed soil samples, with and without *E. inflexa*, were compared with Inderbintzen tests. The presence of the native grass reduced soil erosion in 82%. Results indicate that both grass species, but specially the native, are potential successful plants for gullies revegetation.

**Keywords:** gully, low cost revegetation, native plants, erosion control, plant growth and survivorship

## 52.7.C.4.108

### **REGENERAÇÃO NATURAL DE ESPÉCIES EM UMA ÁREA DEGRADADA SOB PROCESSO DE RECUPERAÇÃO NATURAL REGENERATION OF SPECIES IN AN AREA DEGRADED UNDER RECOVERY PROCESS**

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O presente trabalho foi realizado em uma área degradada pela construção da Usina Hidrelétrica de Ilha Solteira, SP, Brasil, estando a mesma em processo de recuperação há 15 anos. Durante esse período foram implantadas espécies de adubos verdes e, atualmente, está sendo cultivada com *Brachiaria decumbens* Stapf. Este trabalho teve por objetivo fazer o levantamento fitossociológico das espécies arbóreas que surgiram espontaneamente nessa área em processo de recuperação. A amostragem fitossociológica contou com 28 parcelas com dimensão de 10x10m. Em cada parcela foi realizado um levantamento das espécies existentes, sendo as mesmas classificadas. Foram também obtidos os parâmetros fitossociológicos das espécies. No levantamento fitossociológico foram amostradas 88 plantas, sendo a espécie *Machaerium acutifolium* Vogel de maior importância sociológica, apresentando maiores densidade, frequência, dominância, e índice de valor de cobertura. No geral, a área em estudo apresentou baixa diversidade, pois das 88 plantas amostradas, 85 pertenciam à espécie *Machaerium acutifolium* Vogel. As medidas tomadas para recuperação da área estudada favoreceu a regeneração natural dessas espécies. A baixa altura média das plantas, a predominância de diâmetros de caule pequenos, e a baixa diversidade arbórea, indicam que a área está em um estágio sucesional inicial.

**Palavras-chave:** Degradação, espécies espontâneas, fitossociologia.

This study was conducted in an area degraded by the construction of Hydroelectric of Ilha Solteira, SP, Brazil, being in recovery process for 15 years. During this period were implemented green manure species and currently being planted with *Brachiaria decumbens* Stapf. This work objective to make the phytosociological survey of tree species that arose spontaneously in this area in the recovery process. The phytosociological sampling included 28 plots with dimension of 10x10m. In each plot a survey of existing species, which are then classified. Parameters were also obtained phytosociological

species. The phytosociological survey sampled 88 plants and the species *Machaerium acutifolium* Vogel greater sociological importance, showing higher density, frequency, dominance, and index value of coverage. Overall, the study area had low diversity because of the 88 plants sampled, 85 belonged to the species *Machaerium acutifolium* Vogel. Measures taken for recovery of the area studied favored the natural regeneration of these species. The low average plant height, the predominance of small stem diameters, and low tree diversity, indicating that the area is in an early successional stage.

**Keywords:** Degradation, spontaneous species, phytosociology

Devido a cobertura de concreto ou asfalto, nesses estacionamentos acontece o acumulo de grande quantidade de energia solar, atuando negativamente no micro-clima e potencializando então a „ilha de calor“ na cidade.

Entre algumas opções de reação à citada constatação, demonstramos uma possível saída com diversos desdobramentos favoráveis a natureza, ao empreendimento, e principalmente aos visitantes.

**Palavras chave:** permeabilidade do solo, resfriamento evaporativo, balanço da radiação solar

### 53.8.C.3.116

## ILHAS DE CALOR EM CLIMAS QUENTES: AMENIZANDO CONSEQUÊNCIAS DE GRANDES ÁREAS IMPERMEABILIZADAS POR ESTACIONAMENTOS NOS CENTROS URBANOS

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Com o intenso crescimento dos centros urbanos, as edificações e a infra-estrutura avançam sobre a superfície da terra, retirando-lhe a cobertura original de vegetação e ainda impermeabilizando o solo. Por consequência desse evento, a probabilidade de a água da chuva infiltrar-se no subsolo, ou que a mesma seja evaporada vem sendo drasticamente diminuída.

Entre as áreas construídas, além dos densos conglomerados urbanos com suas edificações, podemos sobressaltar nesse grupo ainda: as favelas, muitos dos cemitérios existentes, os quintais e pátios de casas e as ruas e calçadas que formam uma coberta de vedação. Pudemos perceber ainda entre essas áreas mencionadas acima, uma enorme área que é mundialmente utilizada e de forma parecida, que na opinião do autor poderia ser re-pensada e optimizada: os grandes estacionamentos de empreendimentos como shopping-centers e hipermercados.















