

# **Overview of Ongoing Multi-Year Science for Peace Projects**

October 2011

NATO Emerging Security Challenges Division



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# OVERVIEW REPORT OF ONGOING SCIENCE FOR PEACE (SfP) PROJECTS

## EXECUTIVE SUMMARY

This progress report includes information on 48 Science for Peace (SfP) projects that were ongoing as of 31 October 2011. This report is based on summaries submitted by the project directors in the six-monthly progress reports. It briefly reviews the background of each SfP project, provides the main objectives and states the most significant accomplishments in the priority areas overseen by the NATO Political and Partnerships Committee (PPC). In addressing Defence Against Terrorist Threats, advances are noted in the Detection of Explosives as well as Cyber Defence. In addressing Defence against CBRN Agents, accomplishments are described in the area of development of novel Detection Methods for CBRN agents as well as Detection and Decontamination, Destruction and Countermeasures against CBRN agents. In addressing Other Threats to Security, there have been significant accomplishments in areas encompassing Environmental Security and especially Management of Water and other Non-renewable Resources, Radioactive Waste/Tailings, as well as Disposal of Dangerous Chemicals and Pesticides. Progress is also reported in dealing with the protection against Natural Disasters including those caused by Earthquakes and Floods. Also described is important work underway on Energy Security and Security Related Technologies, as well as Security-Related Regional Studies involving three or more Neighbouring Partners, encouraging cross border cooperation. The SfP programme has enabled scientists and engineers from Partner and Mediterranean Dialogue countries to engage in these projects jointly with their counterparts in NATO countries. The training of young scientists, infrastructure development, publications and technical exchanges carried out within the framework of these projects are noted in this report. Also described are some of the concrete measures taken for the implementation of the results through government agencies, private industries, academia and highly placed decision makers.

## INTRODUCTION

The NATO Science for Peace (SfP) Programme was launched in 1997 with the first SfP projects starting their activities in January 1999. This SfP progress report includes a two-page summary report of ongoing projects as of 31 October 2010. These have been organized in three major parts, i.e. "Defence against terrorist threats", "Defence against CBRN agents" and "Other Threats to Security". Each of these parts is further divided into subtopics that relate to the approved priorities of the Political and Partnerships Committee (PPC). Each project summary report includes a numerical reference to the original SfP Project. All projects are listed in Theme order, according to the key priorities and the names and affiliations of the project co-directors, approval date, duration, NATO budget and, if applicable, NATO consultant, other collaborating institutions, intellectual property rights and internet references are provided.

SfP projects are jointly carried out by NATO countries in cooperation with Partner and/or Mediterranean Dialogue countries. These countries are eligible for NATO funding.

- **NATO countries** : Albania, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Iceland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey, the United Kingdom and the United States.

- **Partner countries** : Armenia, Austria, Azerbaijan, Belarus, Bosnia and Herzegovina, Finland, the Former Yugoslav Republic of Macedonia<sup>1</sup>, Georgia, Ireland, Kazakhstan, Kyrgyz Republic, Malta, Moldova, Montenegro, Russia, Serbia, Sweden, Switzerland, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

The following Partner countries are ineligible for NATO funding support, but may participate fully in SPS activities at their own expense: *Austria, Finland, Ireland, Sweden and Switzerland.*

- **Mediterranean Dialogue Countries:** Algeria, Egypt, Israel, Jordan, Mauritania, Morocco and Tunisia.
- **Countries of the Istanbul Cooperation Initiative:** Bahrain, Qatar, Kuwait and the United Arab Emirates

NATO's Istanbul Cooperation Initiative, launched in 2004, aims to contribute to long-term global and regional security by offering countries of the broader Middle East region practical bilateral cooperation with NATO. These countries may participate in SPS activities at their own expense.

- **Global Partner Countries (formerly called Contact Countries):** Afghanistan, Australia, China, Japan, the Republic of Korea, Mongolia, Pakistan and New Zealand.

NATO cooperates with a range of countries which share familiar strategic concerns and key Alliance values and have expressed an interest in deepening relations with NATO. These countries may participate in SPS activities at their own expense.

Participation in NATO's Science for Peace initiative helps Partner and Mediterranean Dialogue scientists to increase contacts in the NATO science community, while building a stronger science infrastructure in their home countries. SFP projects require collaboration between science and industry or between science and governmental authorities.

SFP projects have as essential characteristics:

- relevant to the key NATO SPS Key Priorities
- high quality applied science and technology with a potential for commercialisation in the case of industry-oriented projects
- substantial scientific cooperation among Partner and NATO scientists
- ability to contribute to the solution of problems which not only have long term significance to Partner countries but which also deal with industrial or environmental issues with multilateral ramifications
- ability to promote collaboration among scientists, industry and end-users
- good prospects for promoting the integration of the country's scientists into the international R & D community
- application of modern management practices and techniques
- substantial participation of young scientists

SFP projects are non-proprietary and fully open to inspection by the Project Co-Directors, SFP Programme Staff, the Independent Scientific Evaluation Group (ISEG) and NATO consultants.

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<sup>1</sup> Turkey recognises the Republic of Macedonia with its constitutional name

The ownership of all intellectual property rights and patents on equipment, processes or protocols resulting from a SfP project shall be governed by the national laws and regulations of the participating countries.

Progress on all projects, including the financial status, is reported on a semi-annual basis to the SfP Programme Working Group by 20 April and 20 October each year. Individual progress reports are then compiled in a SfP progress report.



### Science for Peace Projects in Theme Order

Page No.	Project No.	Short Title	Full Title	NATO Country Co-Directors	City	NATO Country	Partners Country Co-Directors	City	Partner Country	Start Date	End Date
17	982823	SfP-Multi-Energy X-Ray Scanner	New Generation of Multi-Energy X-ray scanners for Antiterrorist Inspection	Pochet, Thierry Smith, Craig	Vannes Monterey	France U.S.A.	Rizhikov, Volodymyr	Kharkov	Ukraine	Nov. 2007	Nov. 2011
19	982836	SfP-NQR/NMR Detect Explosives	Highly sensitive NQR/NMR technique for explosive detection	Aktas, Bekir	Bebze-Kocaeli	Turkey	Mozzhukhin, Georgy Slikhov, Kev	Kazan	Russia	Apr. 2010	Apr. 2013
23	983150	SfP-Explosives in Cargo	Detection of Explosives in Cargo by Neutron Resonance Radiography (NRR)	Dangendorf, Volker	Braunschweig	Germany	Vartsky, David	Yavne	Israel	Aug. 2008	Jul. 2012
25	983789	SfP-Detection of Explosives	Highly sensitive stand-off detection of explosives in condensed and gas phase	Schade, Wolfgang	Clausthal	Germany	Keinan, Ehud Rosenwaks, Salman Bar, Ilana Silberberg, Yaron Kosloff, Ronnie	Haifa Beer Sheva  Beer Sheva Rehovot Jerusalem	Israel	Mar. 2010	Mar. 2013
	984196	SfP-Stand-off Detection	NATO STANDEX (Stand-off Detection of Explosives) Programme	Verwaerde, Daniel De Ruitter, Cornelis Palucci, Antonio Charrue, Pierre Becker, Wolfgang Simonet, Francoise	Arpajon  Rijswijk  Frascati Monts Pfinztal- Bergausen Arpajon	France  the Netherlands Italy France Germany  France	Kuznetsov, Andrey Gorshkov, Igor Ter-Martirosyan, Alexander	St. Petersburg	Russia	Feb. 2010	Apr. 2014
27	982480	SfP-Identify Abnormal Conduct	BE SAFE (Behavior IEarning in Surveilled Areas with Feature Extraction)	Cucchiara, Rita	Modena	Italy	Tishby, Naftali	Jerusalem	Israel	Mar. 2007	Nov. 2011
29	980870	SfP-Anthrax	New Biosensor for Rapid Detection of the Anthrax Lethal Toxin	Garber, Eric Stoltenow, Charles	College Park Fargo	U.S.A.	Kolesnikov, Alexander Shemyakin, Igor	Moscow  Obolensk	Russia	Nov. 2005	Oct. 2011
31	982838	SfP-Bacterial Infection Tests	Development of a Novel Immunoassay For the Very Early Detection of Biothreatening Bacterial Infections	Voelter, Wolfgang Vorgias, Constantinos Tsitsilonis, Ourania	Tuebingen  Athens	Germany  Greece	Neagu, Monica Radu, Dorel Lucian	Bucharest	Romania	Nov. 2007	Nov. 2012
33	983154	SfP-Anthtax Detection	Artificial Receptors for Bacillus anthracis Specific Anthrose Detection	Cudic, Predrag	Florida	U.S.A.	Jakas, Andreja	Zagreb	Croatia	Nov. 2008	Oct. 2012

### Science for Peace Projects in Theme Order

Page No.	Project No.	Short Title	Full Title	NATO Country Co-Directors	City	NATO Country	Partners Country Co-Directors	City	Partner Country	Start Date	End Date
35	983207	SfP-Microchip Biodetectors	Biodetectors based on Advanced Microchips	Nabiev, Igor	Reims	France	Oleinikov, Vladimir Artemyev, Mikhail	Moscow Minsk	Russia Belarus	Nov. 2008	Nov. 2011
37	983807	SfP-Nanoparticle-Based Sensors	Nanoparticle-based Sensors for Detection of Chemical and Biological Threats	Merkoci, Arben Polsky, Ronen	Barcelona Albuquerque	Spain U.S.A.	Willner, Itamar	Jerusalem	Israel	Jun. 2010	Jun. 2013
49	982833	SfP-Nerve Agent Antibodies	Development of Scavengers of Organophosphorus Compounds Basing on Catalytic Antibodies	Friboulet, Alain Tramontano, Alfonso	Compiègne Davis	France U.S.A.	Gabibov, Alexander	Moscow	Russia	Oct. 2008	Oct. 2011
41	983638	SfP-Botulinum Toxin Inhibitors	New Inhibitors of Botulinum Neurotoxins	Bavari, Sina Gussio, Rick Burnett, James	Frederick	U.S.A.	Solaja, Bogdan Ospenica, Dejan	Belgrade	Serbia	Aug. 2010	Jul. 2013
43	983510	SfP-GEPSUS	Geographical Information Processing for Environmental Pollution-Related Security with Urban Scale Environment	DeAmicis, Raffaele Skraba, Andrej	Trento Kranj	Italy Slovenia	Stojanovic, Radovan Elhanani, Doron Berkowicz, Simon	Podgorica Rosh Ha-ayin Jerusalem	Montenegro Israel	Mar. 2011	Sep. 2013
45	982620	SfP-Sahara Hydrogen	Sahara Trade Winds to Hydrogen: Applied Research for Sustainable Energy Systems	Lawrence, William Baues, Heinz Lucchèse, Paul Türe, Engin	Washington Düsseldorf Gif-sur-Yvette Istanbul	U.S.A. Germany France Turkey	Benhamou, Khalid Arbaoui, Abdelaziz Loudivi, Khalid Ould Moustapha, Sidi Mohamed	Rabat Meknès Ifrane Nouakchott	Morocco Mauritania	Jun. 2007	Nov. 2010
47	983805	SfP-SCADA Tesbed Simulator	Designing Intelligent, Resilient, Scalable and Secure Next Generation SCADA (Supervisory Control and Data Acquisition) Infrastructure (SCADA-NG)	Zanero, Stefano	Milano	Italy	Simic, Zdenko Lugaric, Luka Kraicar, Slavko	Zagreb	Croatia	Feb. 2010	Feb. 2013
49	977982	SfP-X-Ray-Generator	Development of an Advanced X-Ray Generator Based on Compton Back-Scattering	Botman, Jan	Eindhoven	The Netherlands	Shcherbakov, Alexander	Kharkov	Ukraine	Jan. 2003	Dec. 2012

### Science for Peace Projects in Theme Order

Page No.	Project No.	Short Title	Full Title	NATO Country Co-Directors	City	NATO Country	Partners Country Co-Directors	City	Partner Country	Start Date	End Date
51	983932	SfP-Multi-purpose Magnetic Sensors	Novel Magnetic Sensors and Techniques for Security Applications	Auzinsh, Marcis Budker, Dmitry Gawlik, Wojciech	Riga California Krakow	Latvia U.S.A. Poland	Folman, Ron Alexandrov, Eugene	Beer Sheva St. Petersburg	Israel Russia	Feb. 2011	Jun. 2014
	984091	SfP-Microwave Tunable Devices	Microwave Tunable Materials, Composites and Devices	Jancar, Bostjan Jackson, Timothy	Ljubljana Birmingham	Slovenia U.K.	Belous, Anatoliy	Kyiv	Ukraine	Jul. 2011	
53	981883	SfP-Aqaba Anthropogenic Stress	The Protection of the Gulf of Aqaba from the Anthropogenic and Natural Stress in the face of Global Climate Change	Ediger, Dilek Bat, Levent	Gebze- Cocaeli Sinop	Turkey	Iluz, David Al-Najjar, Tariq	Ramad gan Aqaba	Israel Jordan	Jan. 2007	Apr. 2012
55	982161	SfP-Aqaba Aerosol Pollution	Monitoring Natural and Anthropogenic Aerosol Pollution and its Impact on Ecosystems in the Gulf of Aqaba	Paytan, Adina	Santa Cruz	U.S.A.	Karnieli, Arnon Al-Najjar, Tariq Post, Anton	Beer Sheva Aqaba Jerusalem	Israel Jordan Israel	Jan. 2007	Dec. 2011
57	982481	SfP-Groundwater Desalination	Demonstration of a Novel High Recovery Desalination Process for Brackish Groundwater	Greenberg, Alan	Colorado	U.S.A.	Gilron, Jack Mohsen, Mousa Mahsal, Kholoud	Beer Sheva Zarqa	Israel Jordan	Jan. 2009	Dec. 2011
61	982614	SfP-Sinai Water resources	Assessment and Development of Alternative Water Resources in the Sinai Peninsula, Egypt	Sultan, Mohamed	Michigan	U.S.A.	Soliman, Farouk Rached, Mohamed Mohmoud, Mohamed	Ismailia Ismailia Giza	Egypt	Jun. 2007	Oct. 2012
63	982678	SfP-Black Sea Characterization	Bio-Optical Characterization of the Black Sea for Remote Sensing Applications	Oguz, Temel	Erdemli	Turkey	Palazov, Atanas Lee, Michael Kopelevich, Oleg Malciu, Viorel	Varna Sevastopol Moscow Constanta	Bulgaria Ukraine Russia Romania	Nov. 2009	Nov. 2012
65	982816	SfP-Nitrogen Removal Process	Environmental Security Enhancement through and Innovative Process for Nitrogen Removal	Lyberatos, Gerasimos Kornaros. Michael	Patras	Greece	Shehu, Julian Abou El-Magd, Gamal	Tirana El Minia	Albania Egypt	Aug. 2008	Sep. 2011
67	983134	SfP-Moroccan Water Resources	Investigating salinity and radioactivity in water resources in Morocco	Vengosh, Avner	Durham	U.S.A.	Bouchaou, Lhoussaine Bouguenouch, Bendaoud El Fasskaoui, M'hamed	Agadir	Morocco	Oct. 2008	Oct. 2012
69	983945	SfP-Transboundary Water Pollution in CA	Assessing Transboundary Water Pollution in Central Asia	Steinnes, Eiliv	Trondheim	Norway	Sadyrov, Okiabrin Besterekov, Uylesbek Razykov, Zafar Ismailov, Nasrulla	Bishkek Shymkent Chkalovsk Tashkent	Kyrgyzstan Kazakhstan Tajikistan Uzbekistan	Feb. 2011	Apr. 2014

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Page No.	Project No.	Short Title	Full Title	NATO Country Co-Directors	City	NATO Country	Partners Country Co-Directors	City	Partner Country	Start Date	End Date
	984072	SfP-Water Transboundary Governance	Transboundary Water Governance and Climate Change in the Hashemite Kingdom of Jordan	Khan, Haseen Goebel, Martin Dawe, Paula Pomeroy, Joseph Puestow, Thomas	Dartmouth	Canada	Batarseh, Mufeed El-Hasan, Tayel Al Rawashdeh, Malek Yasin Khlaifat, Abdelaziz	Karak	Jordan	Jul. 2011	Apr. 2015
71	984073	SfP-Bosna River Pollution	Development of a Decision Support System for Reducing Risk from Environmental Pollution in the Bosna River	Makovinska, Jarmilla	Bratislava	Slovak Republic	Kupusovic, Tarik	Serajevo	Bosnia & Herzegovina	Mar. 2011	May 2014
73	984087	SfP-Novi Sad Drinking Water Protection	Drinking Water Quality Risk Assessment and Prevention in Novi Sad Municipality, Serbia	Spanik, Ivan	Bratislava	Slovak Republic	Vojinovic Miloradov, Mirjana	Novi Sad	Serbia	Mar. 2011	Jun. 2014
75	983368	SfP-Desertification in Jordan	Assessment and Monitoring of Desertification in Jordan using Remote Sensing and Bioindicators	Nickling, William	Guelph	Canada	Al-Bakri, Jawad Saoub, Hani Salahat, Mohammad	Amman Amman Zarqa	Jordan	Mar. 2009	Dec. 2012
77	983611	SfP-Desertification Observatory	Desertification Observatory for Environmental and Socio-Economic Sustainability	Iannetta, Massimo	Rome	Italy	Abdel Vetah, Ahmed Ould	Nouakchott	Mauritania	May 2011	May 2014
79	983311	SfP-Uranium Remediation	Remediation processes in uranium and other mining explorations	Pereira, Ruth Sousa José Römbke, Jörg	Aveiro Coimbra Flörsheim	Portugal Germany	Ksibi, Mohamed Haddioui, Abdelmajid	Sfax Beni-Mellal	Tunisia Morocco	Mar. 2009	Feb. 2013
81	982812	SfP-Armenia Pesticides	Inventory, Monitoring and Analysis of Obsolete Pesticides in Armenia for Environmentally Sound Disposal	Holoubek, Ivan	Brno	Czech Republic	Aleksandryan, Anahit	Yerevan	Armenia	Apr. 2009	Apr. 2012
83	983931	SfP-Toxic Pollutant Management	Sustainable Management of Toxic Pollutants in Central Asia: towards a Regional Ecosystem Model for Environmental Security	Sarac, Sezai Koch, Alexander Ciobanu, Romeo-Christian	Istanbul Munich Iasi	Turkey Germany Romania	Kudaibergenov, Sarkyt Khalmanov, Aktam Muhidinov, Zainiddin	Almaty Samarkand Dushanbe	Kazakhstan Uzbekistan Tajikistan	Feb. 2011	Mar. 2014
87	983038	SfP-Pipeline Hazards and Risks	Seismic Hazard and Risk Assessment for Southern Caucasus-Eastern Turkey Energy Corridor	Safak, Erdal	Istanbul	Turkey	Chelidze, Tamaz Akhundov, Arif	Tbilisi Baku	Georgia Azerbaijan	Dec. 2008	Dec. 2011
89	983828	SfP-Seismic Upgrade of Bridges	Seismic Upgrading of Bridges in South East Europe by Innovative Technologies	Dorka, Uwe	Kassel	Germany	Ristic, Danilo Lako, Arian Zenunovic, Damir Folic, Radomir	Skopje Tirana Tuzla Novi Sad	F.Y.R.O.M. <sup>1</sup> Albania Bos. & Herz. Serbia	Feb. 2010	Feb. 2013

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Page No.	Project No.	Short Title	Full Title	NATO Country Co-Directors	City	NATO Country	Partners Country Co-Directors	City	Partner Country	Start Date	End Date
91	983142	SfP-Toktogul Power Station	Geo-Environmental Security of the Toktogul Hydroelectric Power Station Region, Central Asia	Rust, Derek Tribaldi, Alessandro	Portsmouth Milan	U.K. Italy	Korienkov, Andrey Usmanova, Makhira	Bishkek Tashkent	Kyrgyz Repub Uzbekistan	Oct. 2008	Sep. 2012
93	983287	SfP-Moldova Landslides	Landslide Susceptibility Assessment in the Central Part of the Republic of Moldova	Ercanoğlu, Murat	Ankara	Turkey	Boboc, Nikolae	Chisinau	Moldova	Mar. 2009	Mar. 2012
95	983289	SfP-Tien Shan Landslides	Prevention of Landslide Dam Disasters in the Tien Shan, Kyrgyz Republic	Havenith, Hans-Balder Kristekova, Miriam	Liege Bratislava	Belgium Slovakia	Torgoev, Isakbek Abdrakhmatov, Kanatbek Uulu Shailoo, Kasymbek Storm, Alexander	Bishkek Moscow	Kyrgyzstan Russia	Mar. 2009	Mar. 2012
97	983516	SfP-Pripyat River Monitoring	Flood Monitoring and Forecast in Pripyat River Basin	Minarik, Boris	Bratislava	Slovakia	Iarochevitch, Alexei Nabyvanets, Iurii Korneev, Vladimir	Kiyiv Minsk	Ukraine Belarus	Nov. 2009	Nov. 20121
99	983305	SfP-Subsidence Deformation BIH	Development of a Monitoring System to Counter Manage the Risks of Subsidence Deformation on the Population of Tuzla (Bosnia)	Gabianelli, Giovanni Mancini, Francesco	Bologna Bari	Italy	Basic, Abdullah Salihovic, Rusmir Burgic, Mustafa	Tuzla	Bos. & Herz.	Mar. 2009	Dec. 2011
101	983168	SfP-Mediterranean Dialogue Earth Observatory	Real-Time Remote Sensing for Early Warning & Mitigation of Disasters and Epidemics: The Mediterranean Dialogue Earth Observatory	Rochon, Gilbert Ersoy, Okan Altay, Gülay	Lafayette Lafayette Istanbul	U.S.A. U.S.A. Turkey	Rachidi, Tajje-edine El Amrani, Chaker	Ifrane Tangier	Morocco	Sep. 2008	Dec. 2014
105	982811	SfP-Safety of Drinking Water	Microbiological safety of drinking water in Uzbekistan and Kyrgyz Republic	Maux, Melinda	Lille	France	Sharchenova, Ainash Usmanov, Islam	Bishkek Tashkent	Kyrgyz Republic Uzbekistan	Aug. 2007	Jun. 2012
107	982227	SfP-Water Resource Management	Water Resources Management of Agro-Ecosystems in the South Caucasus Transboundary Regions (Armenia, Azerbaijan, Georgia)	Hoogenboom, Gerrit	Griffin	U.S.A.	Bziava, Konstantine Yeghiazarvan, Gurgun Verdiyev Rafig	Tbilisi Yerevan Baku	Georgia Armenia Azerbaijan	Dec. 2006	Dec. 2011
109	983054	SfP-Seismic Maps Harmonization	Harmonization of Seismic Hazard Maps for the Western Balkan Countries BSHAP	Akkar, Sinan	Ankara	Turkey	Glavatovic, Branislav Hoxta, Ismail Kuk, Vlado Zoranic, Amer Garevski, Mihail Kovacevic, Svetlana	Podgorica Tirana Zagreb Serajevo Skopje Belgrade	Montenegro Albania Croatia Bos. & Herz. F.Y.R.O.M <sup>1</sup> .Serbia	Oct. 2008	Oct. 2011

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### Science for Peace Projects in Theme Order

Page No.	Project No.	Short Title	Full Title	NATO Country Co-Directors	City	NATO Country	Partners Country Co-Directors	City	Partner Country	Start Date	End Date
111	983284	SfP-CauSER Teams	Caucasus Seismic Emergency Response (CauSER)	Vergino, Eileen Pantosti, Daniela Türkelli, Niyazi Kalogeras, Ioannis McCormack, David	Livermore Rome  Istanbul Athens  Ottawa	U.S.A. Italy  Turkey Greece  Canada	Javakhisvili, Zurab Arakelyan, Avetis Etirmishli, Gurban	Tbilisi Yerevan Baku	Georgia Armenia Azerbaijan	Jul. 2009	Jul. 2012

## Involvement of NATO and Partner countries in SfP projects

Country	Project Number
Albania	982816, 983054, 983828
Algeria	
Armenia	982227, 982812, 983284
Austria	
Azerbaijan	982227, 983038, 983284
Belarus	983207, 983516
Belgium	983289
Bosnia & Herzegovina	983054, 983305, 983828, 984073
Bulgaria	982678
Canada	983284, 983368, 984072
Croatia	983054, 983154, 983805
Czech Republic	982812
Denmark	
Egypt	982124, 982614, 982697, 982816
Estonia	
Finland	
France	982620, 982811, 982823, 982833, 983207, 984196
F.Y.R.O.M. <sup>1</sup>	983054, 983828
Georgia	982227, 983038, 983284
Germany	982124, 982620, 982697, 982838, 983150, 983289, 983311, 983789, 983828, 983931, 984196
Greece	982816, 982838, 983284
Hungary	
Iceland	
Italy	983142, 983284, 983305, 983510, 983611, 983805, 984196
Ireland	
Israel	981883, 982161, 982481, 983150, 983510, 983789, 983807, 983932
Jordan	981883, 982161, 982481, 983368, 984072
Kazakhstan	983931, 983945
Kyrgyz Republic	982811, 983142, 983289, 983945
Latvia	983932
Lithuania	
Luxembourg	
Malta	
Mauritania	982620, 983611
Moldova	983287

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### Involvement of NATO and Partner countries in SfP projects

Montenegro	983054, 983510
Morocco	982620, 983134, 983168, 983311
Netherlands	977982, 984196
Norway	983945
Poland	983932
Portugal	983311
Romania	982678, 982838, 983931
Russia	977982, 980870, 982678, 982833, 982836, 983207, 983289, 983932, 984196
Serbia	983054, 983638, 983828, 984087
Slovak Republic	983289, 983516, 984073, 984087, 984091
Slovenia	983510
Spain	983807
Sweden	
Switzerland	
Turkey	981883, 982620, 982678, 982836, 983038, 983054, 983168, 983284, 983287, 983931
Tajikistan	983931, 983945
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Tunisia	983311
Ukraine	977982, 982678, 982823, 983516, 984091
United Kingdom	983142, 984091
U.S.A.	980870, 982161, 982227, 982481, 982614, 982620, 982823, 982833, 983134, 983154, 983168, 983284, 983638, 983807, 983932, 984196
Uzbekistan	982811, 983142, 983931, 983945

SfP 982823

## **New Generation of Multi-Energy X-ray scanners for Antiterrorist Inspection**

Project Co-Directors: Dr. Thierry Pochet, DETEC-Europe, Vannes, France (NPD)  
Prof. Volodymyr Ryzhikov, Centre for Radiation Instruments, Kharkov Ukraine (PPD)  
Prof. Craig Smith, Lawrence Livermore National Laboratory, and Naval Postgraduate School, Livermore, Monterey, CA, U.S.A.

Approval Date: 20 June 2007  
Effective Starting Date: 3 November 2007  
Duration: 3 years, until November 2011  
NATO Budget: EUR 297,000

### Abstract of Research

Scientists from France, Ukraine and the United States will develop the working prototype of a new generation of multi-energy X-Ray scanners for antiterrorist use to ensure the quantitative detection of explosives with a probability up to 90-95% and very low false alarm rate. The target is envisaged to be explosives in either solid or liquid form embedded in a backgrounds of inert organic materials with similar densities. Detecting such materials involves a new approach to visualization and recognition using X-rays in the dual- and multi-energy regimes. The project will combine two advances technologies in one and the same instrument, i.e. one which uses multi-monochromatic filters for X-ray emitters (MXF, USA) as well as one which uses energy-selective exclusive scintillation crystals ZnSe (Te) and multi-energy detector arrays based on them (Centre for Radiation Instruments of Institute for Scintillation Materials of Concern "Institute for Single Crystals", Ukraine). It is expected that a combination of these technologies, alongside the development of a new radiographic methods and algorithms for quantitative determination of the atomic and chemical composition of materials, will lead to substantial improvements in sensitivity to illegal and dangerous objects and materials. Participation in the project of such organizations as DETEC-Europe, which is known for its developments in radiation-monitoring instruments, and Lawrence Livermore National Laboratory, a leader in homeland security developments in the USA, should guarantee integration of these joint developments into the security sphere of NATO countries.

### Major Objectives

- Creation of advanced scintillation materials including exclusive ZnSe crystals and development of MER-detectors on their base with improved energy selectivity and radiation stability.
- Creation of an experimental installation using digital radiography with an X-ray emitter of tube voltage up to 200 kV and 3-energy mutli-monochromatic filter acquired from MXF.
- Fabrication of a complete detection assembly including multi-detector arrays, 256-channel receiving-detection circuits, electronics, and power supplies.
- Development of new multi-energy algorithms and special software for separate reconstruction of physically superimposed components of complex objects with substantial improvement (by an order of magnitude) of contrast sensitivity and detection efficiency.
- To build a working prototype of the new generation X-ray scanners (3D dual-energy and/or 2D three-energy) for reliable detection of explosives.
- To improve the quantitative (not just qualitative) reconstruction of the effective number by two-energy radiography with increased accuracy of its determination (from 50-60% to 90-95%).
- To substantially increase the detection probability of explosives from 50% to 80% (within the framework of dual- and three-energy radiography) contained in organic compounds.

### Overview of Achievements since 3 May 2009 until 30 April 2011

- Experimental studies have been continued to evaluate the practical application of multi-energy radiography for distinguishing between materials with similar effective atomic numbers.
- A method is considered for discrimination of substances composing the inspected object by means of determination of effective atomic number  $Z_{\text{eff}}$ . Possibility is shown of separate detection of substances formed by elements with  $Z_{\text{eff}}$  from 6 to 13.
- The complete X-Ray Spectrometer Set Amptek X-123CdTe has been successfully installed and used for the testing and of the experimental setups developed in the Project.
- An Avalanche Photo-Diode Module HAMAMATSU C5331-13 has been successfully installed and used

- Some scientific papers have been prepared and published in international reviewed journals, as well as a number of reports at international conferences have been prepared and presented.

Payments through NATO Funds: EUR 262,701

#### Milestones for the Next Six Months

- Performing of a number of different experiments with explosive phantoms and real objects.
- Improve of advanced MER models and algorithms for the detection of objects by using of MER.
- Improve of specialized software for experimental installation, processing and visual presentation of the radiographic data obtained by using of MER.
- R&D and small-scale production of special electronics for MER and MET scanners.
- Purchasing, testing and tuning of auxiliary scientific equipment for the Project purposes including Computer Equipment and Software, Electronics and Electric Components, etc.
- Preparation of scientific papers and reports, and the presentation of the project results at forthcoming international conferences for Homeland Security in Europe, U.S.A. and Ukraine.

#### Implementation of Results

The expected results of the Project will greatly promote the development and improvement of the homeland security infrastructure of the participating NATO-countries and Partner-countries. The technical development of the project will be used within the framework of approved State programs of Ukraine with the aim of ensuring their security against the world terrorism. Among the most important end-users, one should note the Government of Ukraine (Ministry of Industrial Policy), Ukrainian Customs Authority, Ukrainian National Academy of Science, large high-tech industrial corporations in Ukraine. The Centre for Radiation Instruments of ISMA of ISC has received an order from State Customs Service of Ukraine for improved X-ray scanners, which are to be installed at customs checkpoints at the border between Ukraine and Russia.

NATO Consultant : N/A

#### Other Collaborating Institutions :

- National Academy of Sciences of Ukraine, Kiev, Ukraine
- Ukrainian State Customs Authority, Kiev, Ukraine

#### Intellectual Property (IP) Rights :

Not applicable at this stage

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Abbreviations: ISC: Scientific and Technological Concern "Institute for Single Crystals" of the National Academy of Sciences of Ukraine ; ISMA: Institute for Scintillation Materials of the National Academy of Sciences of Ukraine ; LLNL: Lawrence Livermore National Laboratory ; MXF: Multi-energy X-ray Filter Technologies Inc. ; MER: Multi-energy radiography

SfP 982836

## Highly sensitive NQR/NMR technique for explosive detection

Project Co-Directors: Prof. Dr. Bekir Aktaş, Gebze Institute of Technology, Gebze-Kocaeli, Turkey (NPD)  
Dr. Georgy Mozzhukhin, Kazan State Power Engineering University, Russia (PPD)  
Prof. Dr. Kev Salikhov, Zavoisky Physical -Technical Institute, Kazan, Russia (Co-Director)

Approval Date: 27 January 2010  
Effective Starting Date: 1 April 2010  
Duration: 3 years, until April 2013  
NATO Budget: EUR 332,700

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Information about the SfP Project through Internet: [www.nqr-detection.ru](http://www.nqr-detection.ru)

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### Abstract of Research

The detection of explosives is an issue of extremely importance for modern civilization. There are remains of explosives after the wars and local conflicts as well as the explosives which are used by terrorists around the world. The aviation and public security has a problem of non-invasive detection of the explosives in the baggage, suits, cars, and others. Any achievements in this direction are very important to make the civic life safer. In spite of the availability of various detectors, there are a number of problems to be resolved, such as increasing of the sensitivity, shortening the detection time, decreasing the scanner cost, etc. This project is aimed to develop highly sensitive technique for the explosive detection by nuclear quadrupole resonance (NQR) and low-field nuclear magnetic resonance (NMR). It is well known that most of the explosive and narcotic substances contain nitrogen in their structure. The NQR frequency spectrum is a kind of "passport" of chemical compound. Therefore, NQR on  $^{14}\text{N}$  nuclei is very promising methods for their detection. However, low sensitivity of NQR/NMR even using the pulse technique is still very actual problem. The main difficulty of  $^{14}\text{N}$  NQR detection is small Signal-to-Noise Ratio (SNR) at low NQR frequencies and for detection in the field, an influence of spurious signals from the resonant acoustic ringing and radio-frequency interference signals. On the other hand, NQR technique can not be applied in the case of liquid substances. However they can be successfully detected by NMR technique. Taking into account restriction on application of high magnetic field to scan the luggage and people, only low-field NMR (with frequencies which are close to those of NQR on  $^{14}\text{N}$  nuclei) can be applied. In this case, however we have to discriminate between various liquids by the relaxation parameters of  $^1\text{H}$  signal that is not easy task. This project is intended to solve the sensitivity problem of  $^{14}\text{N}$  NQR, as well as to develop new approaches for liquid substances detection by low field NMR. Several approaches to increase SNR are planned to study in this project. First of them is the application of the original multi-pulse and multi-frequency sequences proposed by the research groups of the partner country to obtain the highest possible NQR detection sensitivity. Second one is the use of the double resonance methods to increase SNR a result of cross-relaxation processes due to the direct contact of the proton and  $^{14}\text{N}$  spin systems. The third approach involves the application of novel technical means for NQR detection of  $^{14}\text{N}$  nuclei, such as the SQUID sensors and high Q (the quality factor) resonators.

### Major Objectives

We hope that the researches, planned in this project, will allow us to avoid major current technology limitations of the NQR method for the practical applications. Specifically we are planning to perform the following studies:

- Two/three frequency experiments for the detection of explosives will be performed to increase an NQR signal sensitivity, exclude the spurious signals and increase the reliability of the detection.
- The study of cross relaxation NQR, the mechanism of the relaxation processes between proton  $^1\text{H}$  and  $^{14}\text{N}$  quadrupole spin systems will be performed to improve the signal to noise ratio of the NQR detection.
- Novel sensors, i.e. the cryogenically-cooled or High-Tc superconductor (HTS) probes and Superconducting Quantum Interference Device (SQUID) sensors will be tested to increase sensitivity of

the NQR detection.

- The NMR experiments for the detection of liquid explosives will be performed. Novel approaches that involve measuring not only the relaxation parameters but also some additional ones are planned to test to provide fast and reliable detection of illegal substances, liquid explosives or their precursor components.
- Models of equipment for the detection of different nitrogen compounds and explosives will be proposed and designed.

Development of novel NQR/NMR techniques that provide **the highest detection sensitivity** in the detection of the explosive compounds is the **general objective of the Project**.

#### Overview of Achievements since the Start of the Project until 30 September 2011

- A database of literature (electronic articles, reviews, patents, books, etc.) on NQR/NMR detection of explosives and narcotics has been settled and made available through the web site of the project.
- The meeting/workshop on Magnetic Resonance Detection of Explosives and illicit materials, MRDE-2011, Yalova, Turkey (18-23 September 2011, [www.mrde2011.com](http://www.mrde2011.com)) has been organized, with participation of leading experts in NQR/NMR explosives detection (the Proceedings will be published in Applied Magnetic Resonance journal [Springer]).
- Two frequency multi-pulse NQR technique with detection on the third frequency has been proposed. This sequence is based on the composite triple  $\nu_- - \nu_0 - \nu_+$  pulses. The sequence has been studied for attenuation of spurious signals in the presence of small metal pieces. A patent application to Russian Patent Office has been submitted for the studied sequence.
- Optimal technique with two frequency preparation pulse with following single-frequency detection has been proposed.
- NQR studies of  $^{14}\text{N}$  nuclei of nitro group in RDX have been made. The NQR frequencies were correlated, the quadrupole constant  $e^2qQ_{zz}/h$ , asymmetry parameters  $\eta$  for nitro group and relaxation parameters for  $\nu_+$  were determined. Double NQR-NQR studies of  $^{14}\text{N}$  nuclei of nitro and amino group atoms in RDX have been made.
- We designed and tested new Q-switch for attenuation of the “ringing” process after radiofrequency pulses at frequency range lower than 1 MHz, designed at Helmholtz coil for field up to 38 mT and volume for sample is near 0.2 l.
- We applied the cross relaxation method for TNT in static magnetic field of 2.5 mT that corresponds to the level crossing for  $\nu_0$  frequency. The results for TNT have been analysed theoretically.
- We carried out the MRI studies of liquid substances and demonstrated its feasibility for explosive detection.
- NMR studies of relaxation parameters and diffusion coefficients for some liquids were obtained. The feasibility of low field NMR for explosive detection has been demonstrated.

Payments through NATO Funds: EUR 174,750

#### Milestones for the Next Six Months

- Analysis of the literature on explosive detection by NQR/NMR.
- Pure NQR experiments, with sub-items:
  - Publication of received results in journals and presentations in conferences.
  - Extending our experiments to test with TNT and ammonium nitrate; theoretical analysis of the experimental results.
- NQR/NMR and NQR-NQR double resonance studies.
  - Experiments in a weak magnetic field and irradiation on proton frequency to average local fields, in ammonium nitrate, TNT and probably with other samples. Double NQR-NQR experiments.
  - Cross-relaxation experiments with matching the proton frequency in a weak static magnetic field for various  $^{14}\text{N}$  transitions (TNT).
  - Theoretical analysis of the experimental results, in relation with the items above, feasibility/ optimal scheme of practical use of the studied double resonance techniques.
- NMR and MRI experiments for detection of liquid explosives
  - MRI experiments on the tomography with use of non-conventional imaging protocols; analysis on the potential use of low field MRI for detection.

- Diffusion and relaxation NMR experiments at low magnetic fields with various liquids.
- Testing of novel magnetic sensors for NQR detection.
- Development of the RF shield box to use with SQUID sensor system.
- Design and tests of high-Q resonating circuits.
- Theoretical analysis of received results, recommendations for design of commercial devices.

### Implementation of Results

End-users: 1) MRI department of Zavoisky Physical -Technical Institute, Kazan, Russian Federation.  
2) EMC Elektronik San Tic. Ltd. Şti., Gebze- Kocaeli, Turkey

Some project results have been reported on the international workshops and conferences. Especially, a possibility to control the detected signal and third non-irradiated transition by tailoring the phases of excitation pulses (applied to other two transitions) was found very prospective with point of view of real applications. The end-users of the project have been informed on the last world achievements in explosives detection as a result of reviewing of the literature and discussion at conferences and workshops. Technical design activities for practical implementation has been started.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

A patent application has been prepared as a result of the project studies and submitted on 20.03.2011 to the Russian Agency for Patents and Trademarks (Federal service on intellectual property, patent and trade marks (Rospatent)). Another patent application was registered in Russian Agency for Patents and Trademarks (Federal service on intellectual property, patent and trade marks (Rospatent)), Application date 18.01.2011, Rospatent reg. No 20111011684.

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SfP 983150

## **Detection of Explosives in Cargo by Neutron Resonance Radiography (NRR)**

Project Co-Directors: Volker Dangendorf, PTB, Braunschweig, Germany, (NPD)  
David Vartsky, Soreq NRC, Yavne, Israel (PPD)

Approval Date: 15 July 2008  
Effective Starting Date: 18 August 2008  
Duration: 3 years, until July 2012  
NATO Budget: EUR 254,500

### Abstract of Research

In this project, we propose to develop a new, cutting-edge method for security-inspection of cargo by means of high-spatial resolution Fast Neutron Resonance Radiography (FNRR). The method is applicable for both border crossings and aviation security. Unlike X-ray radiography systems, FNRR does not rely on human operator skills to identify the shape of the threat. Instead, it enables automatic identification of the concealed contraband by its elemental composition and can reliably detect standard and improvised explosives in solid or liquid form.

The overall objective of this project is to develop a laboratory scale FNRR demonstration facility for automatic detection of standard and improvised explosives in cargo. Within the scope of the project, the principal objective of this research is to develop a novel, high-spatial-resolution Time-Resolved Integrative Optical fast-Neutron (TRION) detector. A proof-of-principle prototype of such a detector developed at our laboratories has already demonstrated that high-resolution fast neutron imaging, suitable for detecting small quantities of thin-sheet explosives is feasible. The 2<sup>nd</sup> generation TRION detector to be developed in this proposal will permit enhancement of system throughput and shorten inspection times. The detector will be evaluated using a laboratory demonstration facility, set up at the PTB particle accelerator.

Furthermore, using the laboratory demo facility, we shall evaluate the capabilities and limitations of the FNRR technology. This is essential in order to define an effective industrialization and exploitation programme by the end of the project.

### Major Objectives

- To develop a 2<sup>nd</sup> generation TRION detector capable of capturing simultaneously several images at different pre-selected energies for each neutron burst. The more energies are sampled, the shorter the inspection time per cargo item.
- Improving the speed of the TRION scintillating fiber screen. The speed of the screen affects resonant contrast and thus influences EDS detection capabilities and the rate of false alarms.
- Design of a scaled-down laboratory prototype of an EDS
- Evaluation of the performance of TRION in a scaled down EDS set up at the PTB neutron irradiation facility. This evaluation will be performed under the guidance and supervision of the end-user (Israeli Police).

### Overview of Achievements since the Start of the Project until 1 May 2011

- Together with the end users we have established the scenario, the type and size of objects which can be inspected with FNRR. The largest object that should be considered for inspection with FNRR is an LD-3 aviation container. The radiation must penetrate the 160 cm width of the inspected object.
- A basic FNRR irradiation geometry was modelled using Monte-Carlo simulation. The main purpose of the simulation is to: 1) Determine the attenuation of the incident neutron flux by containers loaded with different cargo, 2) Establish the number and energy of scattered neutrons that can reach the detector and reduce contrast. 3) Determine the time-of-flight (TOF) of direct and scattered neutrons, 4) Investigate possible anti-scatter post collimators.
- We have calculated and determined experimentally system parameters such as:
  - Spatial point spread function (PSF) due to neutron interaction in scintillating fiber screen
  - Overall spatial PSF of the system
  - Temporal PSF of the system
- We have designed a method for recovering both spatial and temporal resolution by de-convolution.

- A design of a multiframe camera with segmented intensifier was performed. Parts of the equipment have already been procured.
- The most crucial part of the system, the custom made 8-fold segmented photocathode image-intensifier, was commissioned and two prototypes have already been investigated.
- Design and construction of an image-intensifier pulser was finalized and tested using several image-intensifiers. The pulser is capable of pulsing the system with gate times down to 3.2 ns at high (2MHz) repetition rate. 10 units were produced and tested at PTB.
- A system for determining light decay characteristics of scintillators based on Time Correlated Single Photon Counting (TCSPC) was developed.
- Using the TCSPC system we have evaluated the glow curves of 7 scintillators and determined their light-decay times. We have established that a ternary p-Xylene based mixture, saturated with molecular oxygen, provides a relatively bright liquid scintillator with negligible afterglow, well suited for our application.
- We started the generation of transmission images and reconstruction of elemental content.
- We evaluated the quantum efficiency, gating capability and electron cross-talk (emission) of the prototype of custom made 8-fold segmented photocathode image-intensifier.
- We have performed tests of the spatial resolution of the optical chain of TRION.
- The full optical chain of TRION was set up and was evaluated at PTB. However, a key component (the above mentioned 8-fold intensifier) was not according to specification. The company is about 1 year behind time schedule.
- Performance test and optimisation of a TRION with a "slow" 8-fold intensifier in X-ray (PTB) and low energy neutron beams (at Munich research reactor)
- An alternative detection method based on pulse-counting image intensifier (PCI-I) was developed at PTB.
- A TRECOR detector based on the PCI-I was tested in June 2010 using neutron beam at PTB.
- A data evaluation computer program for TRECOR was developed at SOR.
- An initial evaluation of TRECOR results was performed at SOR.
- A new idea for an iterative deconvolving algorithm using a broad kernel was tested at SOR.
- The PCII readout was improved to produce a cleaner image at PTB.
- A calculation of cargo activation was performed at PTB.
- A new approach for elemental reconstruction was initiated in PTB.

Payments through NATO Funds:            EUR 139,882

#### Milestones for the Next Six Months

- Continue the work on the generation of transmission images using MC simulations.
- Calculation of radiation doses in cargo with GEANT4 and MCNP.
- Development of image processing algorithms.
- Development of hardware and software of TRION or TRECOR at SOR.
- Further evaluation on the new generation of 8-fold segmented intensifiers.
- Continue the evaluation of the results from the June 2010 experiment at PTB.
- Perform next experiment at PTB in August 2011.

#### Implementation of Results

The data of the December 2008 PTB run were transmitted to the end-user Supt. Ilan Havardi Israeli Police, Border Crossing division, Jerusalem, Israel and discussed.

With the help of the end-user, a meeting with representatives of a security company **Nuctech** was organized. The method and the project were presented and we explored possibilities of transferring the technology to the company at a later stage. No decision or commitment has been made at this stage.

Contact was also established with representatives of Smiths Detection in 2009 and again in Sept 2010 where the chances of neutron-based methods in cargo scanning were discussed. The present status is that neutrons have first to show their capabilities and the feasibility before a decision of supporting a deployable prototype can be made.

#### Intellectual Property (IP) Rights

Dangendorf V., Kersten C., Vartsky D., Goldberg M.B. Time-resolved, optical-readout detector, for neutron and gamma-ray imaging, World patent# WO2006048871, May 2006.

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SfP 983789

## Highly sensitive stand-off detection of explosives in condensed and gas phase

Project Co-Directors: Prof. Wolfgang Schade, Technische Universität Clausthal, Germany (NPD)  
Prof. Ehud Keinan, Technion-Israel Institute of Technology, Israel (PPD)  
Prof. Salman Rosenwaks, Ben Gurion University of Negev, Israel (Co-Director)  
Prof. Ilana Bar, Ben Gurion University of Negev, Israel (Co-Director)  
Prof. Yaron Silberberg, Weizmann Institute of Science, Israel  
Prof. Ronnie Kosloff, Hebrew University, Israel

Approval Date: 4 December 2009  
Effective Starting Date: 21 March 2010  
Duration: 3 years, until March 2013  
NATO Budget: EUR 240,000

### Abstract of Research

The objective of this project is the development and test of new spectroscopic techniques for the stand-off detection of explosives and other hazardous materials in the gas phase as well as solid state. The combination of stimulated Raman excitation (SRE), coherent anti-stokes Raman spectroscopy (CARS) and quartz enhanced photoacoustic spectroscopy (QEPAS) applying single beam femtosecond or broadband nanosecond laser pulse excitation offers a novel approach and up to now unexplored possibilities for engineering a new generation of multi-compound sensor devices that will find several applications in civil engineering. Complementary characterization methods, including X-ray powder diffraction, differential scanning calorimetry, NMR and mass-spectrometry, will allow focusing the laser techniques on specific spectral characteristics of the tested compounds and thereby improving their identification. Theoretical modeling of the spectroscopic features of the explosives under study will be an essential component of this research program.

### Major Objectives

- Theoretical modeling.
  - Simulation of Raman spectroscopy.
  - Simulation of CARS.
  - Coherent control and optimal control theory.
- Synthesis and characterization.
  - Synthesis of peroxide explosives and unknown analogues.
  - Preparation of plastic compositions of peroxides and other explosives.
  - Characterization of the morphology and crystalline polymorphism of the plastic compositions.
- Development of the QEPAS and the adjusted laser systems, and of the combined SRE-QEPAS systems.
  - Design of QEPAS based sensor.
  - Manufacturing of QEPAS based sensor.
  - Intensity modulation of the laser beams at 32 kHz.
  - Fs and ns SRE-QEPAS spectroscopy of explosives.
  - Functional test of QEPAS based sensor.
  - *In situ* test of the QEPAS sensor in a security gate.
- CARS, PARS and additional technologies.
  - Impulsive fs CARS.
  - Narrowband and broadband ns CARS.
  - Impulsive PARS.
  - Direct detection of acoustic signals at high pulse repetition rates.
  - Laser hole drilling in sealed samples.

## Overview of Achievements since the Start of the Project until 30 September 2010

In this annual report we have prepared peroxide based explosive samples of TATP and DADP, and in addition, we have focused on a variety of plastic compositions of TATP. Currently we are testing silicon sealants, polyethyleneglycole (PEG) and polyvinyl acetate (PVA) as polymer binders. A comprehensive report will be given by mid 2011.

Payments through NATO Funds: EUR 60,094

### Milestones for the Next Six Months

In addition to the experiments mentioned before, we are planning to investigate the explosive properties of various plastic compositions of TATP by thermo gravimetric analysis (TGA), BAM friction test and impact tests.

### Implementation of Results

The German and the Israeli groups have long going relationships with variety of security organizations and with commercial enterprises that develop and market security-related products. Therefore, it seems natural that these bodies will be informed about the results of this proposed research in order to implement them first in field experiments and later in commercial explosive detectors. For example, in Germany the developed technology will be applied and tested during the project by KABA Gallenschütz GmbH as an upgrade of their security gates frequently used at airports, sports events etc. The company Diehl BGT Defence GmbH will apply this new technology for standoff applications on robotic platforms and the new spin-off company MIOPAS GmbH has interest in manufacturing laser based standoff detection systems. In addition, FIS GmbH will give impacts how this new technology can be applied at airport security systems and what are the necessary requirements. This information will be important when designing a system based on the technology developed in this project. Field experiments will be done in cooperation with FIS at special airport facilities. In Israel much of the implementation and field experiments with actual samples of explosives will be done with the Division of Identification and Forensic Sciences (DIFS) and with the bomb squads of the Israeli police, the security unit of Ben Gurion Airport and with the Israel Security Agency (ISA). In addition, four relevant Israeli companies that specialize in the developemtn of explosive detectors are Acro Security, Xurity, Ray Technologies and Laser Detect Systems. All four companies were involved in past collaboration projects with the Israeli groups.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

### Intellectual Property (IP) Rights

There are no IP rights for the Project at the moment.

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Abbreviations: BGU: Ben-Gurion University of Negev, CARS: Coherent anti-Stokes Raman spectroscopy (or scattering) ; CREATE: Center for Risk and Economic Analysis of Terrorism Events (USA) ; DHS: Department of Homeland Security ; LIBS: Laser induced breakdown spectroscopy ; LIF: Laser induced fluorescence ; NMR: Nuclear magnetic resonance ; PARS: Photoacoustic Raman spectroscopy (or scattering) ; QEPAS: Quartz enhanced photoacoustic spectroscopy ; SRE: Stimulated Raman excitation ; WIS : Wismann Institute of Science

SfP 982480

## **BE SAFE (Behavior IEarning in Surveilled Areas with Feature Extraction)**

Project Co-Directors: Prof. Rita Cucchiara, University of Modena & Reggio Emilia, Modena, Italy (NPD)  
Prof. Naftali Tishby, the Hebrew University, Jerusalem, Israel (PPD)

Approval Date: 24 October 2006

Effective Starting Date: 19 March 2007

Duration: 4 years, until July 2011

NATO Budget: EUR 219,190

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Information about the SfP Project through Internet: <http://imagelab.ing.unimore.it/besafe>

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### Abstract of Research

This project is unique since it aims at combining two main areas of research, Computer Vision and Machine Learning, in an application of automatic surveillance for people detection and tracking and abnormal behavior recognition. The project aims at exploring how visual features can be automatically extracted from video using computer vision techniques and exploited by a classifier (generated by machine learning) to detect and identify suspicious people behavior in public places in real time. In this sense, CV and ML are jointly developed and studied to provide a better mix of innovative techniques.

Justification of the proposed project is based on two issues of major concern to the state of Israel: (1) the need for intelligent surveillance in public and commercial areas that are susceptible to terrorist attacks and (2) lack of automatic and intelligent decision support in existing surveillance systems. More specifically, the objectives of the project are: (1) to achieve a better understanding of which visual features can be used for (1.a) analyzing people activity and (1.b) characterizing people shape; (2) to suitably adapt ML techniques such as HMM, SVM or methods for "novelty detection" in order to infer from the visual features extracted the behavior of the people and possible classifying it as normal or abnormal; (3) develop a first simple prototype in a specific scenario that can be considered as a threat for security. The machine learning component is based on the following phases: (1) constructing a generative statistical model of human gait on the basis of the features provided by the CV group. Such a model is an adaptation of an oscillatory dynamic model we developed in the past, where different points on the walking person are assumed having a drifted oscillators motion with characteristic frequency and relative phases; (2) this basic Oscillatory Gait Model (OGM) is then plugged as the output of a state of an HMM, yielding a complete statistical model of regular gait; (3) detecting deviations (irregularities) in the relative phases and amplitudes of the OGM to capture irregular behavior, e.g. halting, bending, leaving objects, etc. The output of such a statistical model can be classified using clustering or standard classifiers as SVM to improve confidence. (4) We also carried work on detecting statistical irregularities in multivariate correlated data, as another component of the project.

### Major Objectives

- Study and development of computer vision algorithms for people detection and tracking in multi-camera systems.
- Study and development of computer vision algorithms for people activity detection.
- Study and development of computer vision algorithms for people shape analysis.
- Study and design of a dynamic gait model based on coupled oscillatory motion.
- Development of machine learning techniques for abnormal behaviour detection.

### Overview of Achievements since the Start of the Project until March 2011

- Developing a new approach for modeling human gait (GOM) and model it statistically using autoregressive processes (concluded).
- Use the GOM as a state output model of an HMM for a complete statistical model of human motion (concluded).
- Use the graph Laplacian formulation, proved very successfule for detecting irregularities in multivariate data (concluded).

- Development of a complete tool for extracting visual features (people detection and tracking with correspondent features) from a system of multiple cameras with partially overlapped FOVs (concluded).
- Further enhancement of solutions for analyzing people trajectories to account for multi-modal and sequential trajectories in order to infer behaviors (concluded).
- Study of a system for people shape analysis based on action signature (concluded).
- Creation of a video repository for annotated surveillance videos (concluded).
- Development of a system for people tracking in freely moving cameras (concluded).
- Development of a system for markerless modeling of human actions from multiple cameras (concluded).
- Organization of the first ACM International Workshop on Vision Networks for Behaviour Analysis (ACM VNBA 2008) – <http://imagelab.ing.unimore.it/vnba08> - Vancouver, BC (Canada), October 31, 2008 (concluded).
- Development of an integrated framework UNIMORE-HUJI for anomaly detection for people trajectories (concluded).
- Deep testing of the framework with more real data (under development).

Payments through NATO Funds: EUR 181,529

#### Milestones for the Next Six Months

Further tests to validate the developed approached.

#### Implementation of Results

NATO Consultant : N/A

#### Other Collaborating Institutions

Magal Security Systems (MSS), Ltd., P.O.Box 70, Industrial Zone, 56000, Yahud, Israel

#### Intellectual Property (IP) Rights

There are no IP rights for the Project at the moment.

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Abbreviations: MSS- Magal Security Systems, Ltd.; PPD- Partner Project Director; NPD- NATO Project Director; CV- Computer Vision; ML- Machine Learning; FOV- Field of View; OGM- Oscillatory Gait Model; HMM- Hidden Markov Model; SVM- Support Vector Machine; PTZ- Pan-Tilt-Zoom

SfP 980870

## New Biosensor for Rapid Detection of the Anthrax Lethal Toxin

Project Co-Directors: Eric A.E. Garber, PhD, FDA, CFSAN, College Park, U.S.A. (NPD)  
Alexander V. Kolesnikov, PhD, BCH RAS, Moscow, Russia (PPD)  
Charles L. Stoltenow, PhD, NDSU, Fargo, U.S.A. (Co-Director)  
Igor G. Shemyakin, PhD, SRCAMB, Obolensk, Russia (Co-Director)

Approval Date: 15 November 2005  
Effective Starting Date: October 2006  
Duration: 4 years, until October 2011  
NATO Budget: EUR 258,000

### Abstract of Research

Inhalational anthrax is nearly always fatal unless treatment begins early in the course of the disease. Early start of treatment or prophylaxis depends on the timely accurate detection of anthrax. Current clinical assays do not target the anthrax lethal toxin. Rapid anthrax detection based on PRC, detection of *B. anthracis* DNA is vulnerable to hoaxes because it yields positive results if perpetrators release DNA or vaccine strain rather than virulent lethal bacilli. Available immunodetection methods rely on the identification of specific surface antigens may misidentify nonlethal strains of *Bacillus* that contain similar surface antigens or miss lethal strains that lack the specific surface antigen. Microbiological and toxicological analyses that identify pathogenic anthrax strains with high degree of confidence can take days. The proposed research addresses the lethal factor as the target for anthrax detection. The use of peptides containing highly specific LF cleavage sites eliminates the chance of false positives due to the presence of related nonlethal bacilli or anthrax DNA at the sample. Development of specific and sensitive detection techniques based on new peptide substrates and modern fluorescence-based technologies would enable detection of the LF at levels previously not attainable.

### Major Objectives

- Develop a highly sensitive bioassay for the detection of lethal factor (LF), the toxin of the anthrax pathogen *Bacillus anthracis*, based on the specificity of the toxin to cleave peptide bonds at a unique amino acid sequence.
- Adapt the technology to enable the detection of LF in a wide variety of environments (matrices).
- Develop an assay for the clinical detection of LF.

### Overview of Achievements since the Start of the Project until July 2011

- New assay format was developed that can sense up to 50 fg/ml of LF proteolytic activity *in vitro*. This value corresponds well to the sensitivity of recently reported assays based on the variants of the immuno PCR. Provided that in the clinical and environmental specimens, inhibitory compounds can be present that decrease the assay sensitivity, the value of the detection limit obtained should be sufficient to obtain the sensitivity necessary for early detection of anthrax toxin in blood and microbiological samples.

Payments through NATO Funds: EUR 208,212

### Milestones for the Next Six Months

- **Task 8** Adaptation of the solid-phase LF assay.  
The *in vitro* tested LF assay will be analyzed using blood samples spiked with LF and blood samples obtained from animals infected with vaccine strain of *B. anthracis* secreting intact anthrax lethal toxin (STI-1) in order to obtain the final parameters for the assay sensitivity.
- **Task 10** Documentation and training of end-user.  
Protocols for production of assay components and for carrying out assay.

### Implementation of Results

Patent applications disclosing new format of the LF PCR-based assay and LF-specific monoclonal antibody and its use in assays are being prepared. A paper is under preparation describing results obtained and new assay principle. The application to the Ministry of Industry and Trade of the Russian Federation to participate in PHARMA-2020 program in order to develop sensitive assays to detect anthrax and botulinum toxins is submitted to the appropriate governmental body. Protocols for preparation of new assay components are transferred to Obolensk and to Asinex for evaluation and preparation for assay kit development.

NATO Consultant : N/A

Other Collaborating Institutions : N/A during the current reporting period

### Intellectual Property Rights

Russian patents disclosing principle of CA-LF assay **2418860** and new substrate for this assay **2416637** are received.

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Abbreviations: LF, Lethal factor; FRET, fluorescence resonance energy transfer; AP, alkaline phosphatase; CA, coupled-amplified; mAb, monoclonal antibody

SfP 982838

## **Development of a Novel Immunoassay For the Very Early Detection of Biothreatening Bacterial Infections**

Project Co-Directors: Wolfgang Voelter, University of Tuebingen, Tuebingen, Germany (NPD)  
Monica Neagu, "Victor Babes" National Institute of Pathology, Bucharest, Romania (PPD)  
Dorel Lucian Radu, "Cantacuzino" National Institute Bucharest, Romania  
Constantinos Vorgias, University of Athens, Athens, Greece  
Ourania Tsitsilonis, University of Athens, Athens, Greece

Approval Date: 20 June 2007  
Effective Starting Date: 23 November 2007  
Duration: 4 years, until November 2012  
NATO Budget: EUR 300,000

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Information about the SfP Project through Internet: <http://www.ivb.ro/index.php?p=nato982838>

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### Abstract of Research

Development of an ELISA that can detect very early events induced in host immune cells infected with biothreatening pathogens.

### Major Objectives

- Elucidation of the relevance of the C-terminal peptide fragments of proTα's excretion to early apoptosis of monocytes/macrophages induced upon their *in vitro* infection with pathogenic bacteria.
- Development of a very sensitive and specific diagnostic tool (immunoassay in the format of an ELISA) for the detection of the released into blood plasma proTα fragments.
- Validation of this diagnostic tool in infected animal models.
- Validation of this diagnostic tool in infected and non-infected humans at the onset and during the course of infectious diseases.
- Implementation of the end-results of the project towards commercialization .

### Overview of Achievements since the Start of the Project until 30 March 2011

- We have investigated the effect of ProT alpha and its C-terminal on the respiratory burst of mice infected with relevant bacterial strains.
- Up-dating the web-site of the project as an important educational and organizational tool.
- Results dissemination as communication and publications.

Payments through NATO Funds: EUR 190,199.52

### Milestones for the Next Six Months

For Partner Countries:

- Focus on animal models of infection relevant for peptide detection.
- ELISA quantification on peptides in infected mice.
- ELISA quantification on peptides in humans diagnosed with bacterial infections.

For NATO Countries:

- ELISA set up for the detection of proTα(100-109) in sera of infected mice with pathogenic bacteria.
- Finalization of manuscript on the activity of proTα(100-109) on human neutrophil functions. Submission to "Immunobiology".
- *In vivo* testing of the immunomodulating activity of the decapeptide proTα(100-109) and evaluation of results.
- Detection of peptide proTα(100-109) in the culture supernatants of HeLa cells subjected to oncotic and necrotic death.

### Implementation of Results

During the reported period intensive consultations for implementation of the results were done by NPD with the end-user Panatech Company.

PANATecs GmbH, Ob dem Himmelreich 7, 72074 Tuebingen, Germany

Tel: +49 7071 2972074

Fax: +49 7071 29 4445

e-mails: flad@panatecs.com/cansier@panatecs.com/web site: www.panatecs.com

The new website of the project <http://www.ivb.ro/index.php?p=nato982823> was established .

In the reported 6 months two young scientists training was performed related to the topic of the project.

NATO Consultant : N/A

### Other Collaborating Institutions :

E-Biotech BVBA, Zonhoven, Belgium, is participating in the project by producing monoclonal and polyclonal antibodies against the prothymosin alpha decapeptide of interest. Contact person: Dr Eugene Bosmans (Tel: 0032 477 312169; E-mail: eugene.bosmans@pandora.be)

### Intellectual Property (IP) Rights :

Not applicable at present.

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SfP 983154

## Artificial Receptors for *Bacillus anthracis* Specific Anthrose Detection

Project Co-Directors: Dr. Predrag Cudic, Torrey Pines Inst. for Molecular Studies, Florida, U.S.A. (NPD)  
Dr. Andreja Jakas, Rudjer Boskovic Institute, Zagreb, Croatia (PPD)

Approval Date: 23 July 2008  
Effective Starting Date: 1 November 2008  
Duration: 3 years, until April 2012  
NATO Budget: EUR 208,000

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Information about the SfP Project through Internet: <http://sites.google.com/site/sfp983154/home>

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### Abstract of Research

Anthrax is an acute infectious disease caused by the spore-forming bacterium *Bacillus anthracis*. When *B. anthracis* spores enter the human body, anthrax infection is often deadly. Since the anthrax spores can be produced in large quantities using basic technology, there is a real threat that terrorist groups will use anthrax as a biological weapon. Croatia's geographical location, active involvement in UN led or endorsed peacekeeping missions, and orientation of country's economy on tourism made Croatia very sensitive on possible terrorist attack. Possibility of smuggling *B. anthracis* as a terrorist weapon into the country during the peak of touristic season when fluctuation of people is high, and level of border controls reduced is particularly frightening. Therefore, development of rapid and sensitive detection method for *B. anthracis* will minimize the possibility of such attacks, or in the case of the attack will assure rapid diagnosis and adequate medical assistance to infected person(s). Our research goal is to develop a novel *B. anthracis* sensory system based on the detection of a unique saccharide, anthrose, which is present exclusively on the surface of *B. anthracis* spores. To achieve this goal we propose preparation of novel anthrose specific sensors based on modified peptide antibiotic polymyxin. Advantages of our approach include relatively simple structure of the sensory molecule, ease of synthesis, unlimited access to sensor's synthetic analogs, storage stability and low cost.

### Major Objectives

This research proposal describes solid-phase synthesis of novel cyclic peptide receptor, its optimization using combinatorial chemistry approach, and library screening for optimal anthrose binding. Completion of the proposed studies will pave the way for the design and synthesis of new photophysical sensors for anthrose monosaccharide, and thus new detection systems for rapid and selective *B. anthracis* spores detection. The research objectives are as follows:

- Solid-phase synthesis of bicyclic peptide scaffold 1 combinatorial library
  - Synthesize bicyclic peptide 1 soluble combinatorial libraries by the process of divide, couple and recombine using standard Fmoc solid-phase methodology.
- Synthesize anthrose and glucose lipidic derivatives
  - Synthesize in solution anthrose lipidic derivative 7.
  - Synthesize in solution glucose lipidic derivative as a selectivity control substrate.
  - Immobilize anthrose 7 and glucose derivatives on the microtiter plate.
- Library screening
  - Screen peptide 1 library for anthrose binding using UV/Vis based assay.
  - Identify and characterize compound(s) with highest anthrose affinity and selectivity.

### Overview of Achievements since the Start of the Project until 10 October, 2011

Within the three years of the project period we have successfully synthesized bicyclic peptide library, control glucose and anthrose lipidic derivatives (Objectives 1 and 2). Glucose and anthrose prepared lipidic derivatives were used in peptide library screening for selective anthrose binding. Synthesis of bicyclic peptides with the highest affinity and selectivity for anthrose, as a result of the screening assay, is currently ongoing

Josipa Suc, a new young investigator, started working on the project during the fall 2010. The basic concepts of the carbohydrate synthesis and automated solid-phase peptide synthesis were introduced to

this young investigator. Ms. Suc participated in conducting library screening during her visit to Dr. Cudic laboratory. Ms. Suc actively participates in all phone conferences and discussions related to the project and described research activities.

The project website is maintained and updated by the Linija Koda d.o.o. company.

Payments through NATO Funds : EUR 159,747

#### Milestones for the Next Six Months

- Synthesis and characterization of bicyclic peptides selected from the library screening with high affinity and selectivity toward anthrose monosaccharide.
- Determination of selected peptides affinities toward anthrose using fluorescence spectroscopy and isothermal titration calorimetry experiments.

#### Implementation of Results

Possibilities of anthrax use as a biological weapon by terrorist groups necessitate development of rapid and efficient detection methods. Existing methods for detection and identification of *B. anthracis* spores are complex, expensive and time consuming, justifying therefore development of new and alternative approaches. Our short term research goal is to develop new anthrax sensors based on the recognition of *B. anthracis* specific monosaccharide anthrose. Advantages of this approach include small size and relatively simple structure of sensory molecule, ease of synthesis, storage stability and low cost. As long term goals, these sensors will be used for further development of new portable *B. anthracis* detectors for use by non-specialists. Since activities of the Rudjer Boskovic Institute besides basic science include applied research and development as well, at this stage of the project Co-Directors will seek collaboration with the scientists and engineers within the Rudjer Boskovic Institute community. For example, such collaboration is feasible with the development of optical and optoelectronic devices. In the final stages, commercialization plan for the final product will be developed with support of the Rudjer Boskovic Institute, and possible economic partners will be identified.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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SfP 983207

## **Biodetectors based on Advanced Microchips**

Project Co-Directors: Prof. Igor Nabiev, URCA, Reims, France (NDP)  
Dr. Vladimir Oleinikov, SOIBC, Moscow, Russia (PPD)  
Dr. Mikhail Artemyev, IPCP, Minsk, Belarus (Project Co-Director)

Approval Date: 23 July 2008  
Effective Starting Date: 17 November 2008  
Duration: 3 years, until November 2011  
NATO Budget: EUR 267,000

### Abstract of Research

This project will couple the emerging nanotechnologies with the protein microarrays and liquid phase NCs-encoded chips technologies through the application of highly-sensitive conjugates of highly luminescent semiconductor NCs with capture molecules as detecting probes. Additionally, a FRET-based conception for detection of fluorescent signal from the molecules immobilized in micro spots or on the surface of liquid-phase chip will remarkably improve the detection sensitivity due to the decrease of the nonspecific signal contribution.

### Major Objectives

- Develop the bio-detector kits employing multi-color, multi-marker microbeads for biodetection using the flow cytometry set-up for single-bacteria and/or single-virus early detection.
- Develop the bio-detector system employing multi-color NCs conjugated antibody detectors applied to the all-protein and mAb microarrays (chips) for simultaneous detection of multiple bacterial and/or viral markers.
- Develop advanced read-out instrumentation for application of NCs-based markers in the fluorescence detection schemes.
- Realize the FRET-format for detection on the solid-phase protein microarrays and liquid phase chips using fluorescent NCs and NC-encoded microbeads as the energy donors and the organic dye labels or nanogold® particles as the energy acceptors.
- Apply the developed innovative set-up to early detection of bacteria stains that are slow growing (e.g., *Mycobacterium*), or highly infectious (e.g., *Bacillus anthracis*) and simultaneous detection of different bacterial and/or viral species in a single sample using the bacterial *Meningitis* infectious agents detection as a proof-of-the-principle multiplexed demonstration.
- Accomplish the patenting procedures, prepare commercial prototypes, implement the results of project involving the end-users and license new technologies.

### Overview of Achievements since the Start of the Project until 30 March 2011

- Large-scale production of highly luminescent hydrophobic NCs of at least three different colors (Milestone 1).
- Small-scale production of double-band emitting NCs (Milestone 2).
- SSS Ltd. is start to manufacture of the NCs-tagged polymeric beads, as-synthesized NC and of water-solubilized functionalized NCs, on the base of CdSe/ZnS core/shell NCs. (Milestone 3).
- Development of the synthesis of polymeric MBs encoded with the NCs of two different colours (Milestone 4).
- Start of production of water-solubilized highly luminescent NCs (Milestone 5).
- Large-scale production of near-IR and double-band emitting NCs (Milestone 6).
- Start of production of operational conjugates of water-soluble NCs with Oligs and Abs (Milestone 7).
- Two articles presented the breakthrough results of the application of FRET-format to the quantitative bio-detection on the solid-state microarrays accepted for publication (Milestone 9).
- The article on the application of FRET-format to the quantitative biodetection with the nanocrystal-encoded microbeads was published (Milestone 11).

- Proof of the Concept of multiplexed bio-detection on the example of three cancer markers was demonstrated (Milestone 11).

Payments through NATO Funds: EUR 267,000

#### Milestones for the Next Six Months

**Milestone 8.** Patent application on the use of the NCs-based biodetection system operating in the FRET-regime.

**Milestone 12.** Accomplishment of patenting procedures and transfer of technology to NST and SSS; start of commercialisation of solid-state and liquid-phase biodetectors will occur within the 3<sup>rd</sup> year of the project.

Publication of results of:

- Designing of specific instrumentation for biodetection on the base of NCs (Task 4.2)
- Development of the protocols of FRET-format for solid-state biodetection (Task 4.3)
- Development of the specific instrumentation for solid state (Tasks 4.2-4.4) and liquid state (Tasks 5.2-5.3) biodetection
- Development of bio-detectors prototypes, on the example of Y.Pestis antigen detection (Task 6.1)
- Development of the multiplexed detection by flow cytometry and microspectroscopy techniques (Task 6.2)

#### Implementation of Results

Two end-users had been involved in the Project:

(1) "SSS-Innovation Ltd." The methods of the fluorescent microspheres preparation were delivered to the "SSS-Innovation Ltd." where design of technological line for this reagent manufactured was developed.

(2) "NanoScan Technologies Ltd." which is specialized in developing and manufacturing of microspectroscopy tools developed the design of the special instrument for optimal excitation and readout of data from the microchips based on nanocrystals.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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SfP 983807

## Nanoparticle-Based Sensors for Detection of Chemical and Biological Threats

Project Co-Directors: Prof. Arben Merkoçi, Institut Catalana de Nanotecnologia, Barcelona, Spain (NDP)  
Prof. Itamar Willner, the Hebrew University, Jerusalem, Israel (PPD)  
Dr. Ronen Polsky, Sandia National Laboratories, Albuquerque, NM, U.S.A.

Approval Date: 8 December 2009  
Effective Starting Date: 22 June 2010  
Duration: 3 years, until June 2013  
NATO Budget: EUR 165,000

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Information about the SfP Project through Internet: ***to be created***

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### Abstract of Research

The objective of the proposed project is the development of electrochemical/optical nanoparticle-based sensing platforms capable of detecting biological and/or chemical warfare agents. The development of highly sensitive and field deployable electrochemical/optical devices capable of sensing biological and/or chemical (explosives and toxins) targets would greatly aid the war on terror by providing a means of fast and accurate detection of warfare agents. The research will also enable advancements in autonomous detection of multiple targets which may be useful for monitoring production facilities, transportation systems and high-profile public buildings.

### Major Objectives

- Develop schemes based on molecular imprinting of AuNPs for detection of Chem/bio agents.
- Explore optical and electrochemical detection methods.
- Explore novel nanoparticle-based detection schemes using nanoporous membranes and porous carbon.
- Develop fluidic chips for integration of nanoparticle-based detection.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Catalytic nanoparticles were deposited onto porous carbon substrates.
- AuNP based immunoassay for model proteins (i.e. thrombin) and a model toxin were developed or still in progress by using antibodies modified AAO membranes.
- Molecular imprinting of aniline-AuNPs were coated onto glass slides for explosive detection.

Payments through NATO Funds: EUR 21,173.10

### Milestones for the Next Six Months

- Porous carbon substrates will be explored for chem/bio detection in a possible collaboration with Prof. J.Wang.
- Fabrication of nanochannel based devices (optical/electrochemical) will continue.
- AAO membranes will be developed for DNA and toxin detection.
- Molecular imprinting of quantum dots will be explored.

### Implementation of Results

At this stage of the project the sensor design/s as the result of the collaboration between the three groups has not yet been completed. This activity will most probably include collaborations with other institutes and companies that might be interested in the further technological development.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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SfP 982833

## Development of Scavengers of Organophosphorus Compounds Basing on Catalytic Antibodies

Project Co-Directors: Alain Friboulet, UTC, Compiègne, France (NPD)  
Alexander Gabibov, BCH RAS, Moscow, Russia (PPD)  
Alfonso Tramontano, UC David, Davis, USA (Co-Director)

Approval Date: 20 June 2007  
Effective Starting Date: 1 October 2007  
Duration: 4 years, until October 2011  
NATO Budget: EUR 230,000

### Abstract of Research

Nerve agents (NAs) are some of the most deadly substances on Earth, perhaps second only to proteinaceous neurotoxins such as botulinum toxin. NAs are nearly the ideal terrorist weapon. Tragically, NAs have already been employed by terrorists twice and by at least one rogue government against both opposing military forces and its own people. All NAs are based on the organophosphorous (OP) chemistry. One approach to protect population from NA attack is the use of enzymes such as cholinesterases (ChEs), as single pretreatment drugs to sequester highly toxic agents before they reach their physiological targets. Bovine serum AChE (FBS-AChE), or equine serum butyrylcholinesterase (Eq-BuChE), or human serum BuChE (Hu-BuChE) protected the animals from multiple LD<sub>50</sub> of a variety of highly toxic OPs without any toxic effects or performance decrements.

Several issues, such as potential immunogenicity and relatively fast clearance that can limit the utility of ChEs as NA scavengers, are inherent to the idea of use of BuChE (or other enzymes) as OP scavengers. Catalytic antibodies obtained against OPCs can serve as viable alternative for development of therapeutics for scavenging of NAs. The proposed Project is focused at the development of catalytic antibodies capable to form stable adduct with an NA thus providing a prototypic antibody-based molecule for prophylaxis and therapy of NA poisoning.

### Major Objectives

- To demonstrate that catalytic antibodies covalently reacting with OPCs are able to prevent (or at least to significantly decrease) intoxication by nerve agents in mice;
- To improve the properties of the existing antibody scavengers;
- To isolate fully human antibodies that form covalent adducts with OPCs
- To provide technology transfer and further R&D support to the End-user for preclinical development of the identified antibodies into prototype drugs targeting chronic and acute OPC intoxication.

### Overview of Achievements since the Start of the Project until July 2011

- The development of fluorogenic organophosphorus substrates mimicking the structural properties of nerve agents, and the analysis of *in vitro* OPC-scavenging kinetics of 9A8 antibody using these substrates have been completed.
- The preparation of transition state analogs and reactive baits for monoclonal antibody induction and phage library screening has been achieved.
- *In vitro* affinity maturation of 9A8 antibody in order to enhance its OPC-scavenging capacity has been further investigated.
- The generation and characterization of monoclonal antibodies reactive with OPCs in autoimmune-prone mice was also experimented.
- The conversion of 9A8 antibody and/or its evolved variant(s) into IgG, and expression of the modified antibody in mammalian expression system was done.
- Isolation and characterization of fully human antibodies with potential to scavenge OPCs using phage display approach was further developed.
- The comparative structural and functional analysis of isolated antibodies in order to identify best performing species has been started.
- Expression and purification of rh9A8 and rhA17 mAbs was performed.

- Crystal structure of mAb A17 was solved both with and without organophosphate compound in its active site.
- Phage-selected antibodies were identified with potentially scavenging activity and their biochemical properties were studied.
- The differences of reactive nucleophilic residues indicate the existence another active site machinery and gave possibility to improve the scavenging properties by rational design and shuffling of the antibodies CDR's.
- To perform of optimization production and purification of recombinant scavenging antibody the expression of A17 antibody in yeast system was made.
- The Fab-fragment of A17 antibody produced using yeast expression system has similar kinetic parameters toward model aryl-phosphonate.
- To improve the scavenging activity of anti-OPC antibody the crystal structure of A17 active site was investigated and six mutants were proposed.
- Changing of CHO-expression system to the *Pichia Pastoris* yeast system lead to increased yields and purity.
- Standard operating protocols were established for the scaling up of expression and purification processes.
- Mutation of amino acid residues to enhance the nucleophilicity of reactive tyrosin dramatically decreased the activity of the A17 antibody.

Payments through NATO Funds: EUR 196,038

#### Milestones for the Next Six Months

- Crystallization of FabA5 antibody with OPC ligand and further structure analysis will be performed.
- The MD analysis of anti-OPC antibody A17 and A5 interactions with panel of OPC will be performed.
- The large-scale production and purification fo recombinant yeastFab-fragments of antibodies-antidote according to newly generated SOPs will be realized.
- Standardized technical protocols will be transferred to the end-user.

#### Implementation of Results

PPD organized a workshop together with the end-user to outline future joint actions and to familiarize representatives of the End-user with results obtained during the first reporting period. Tech transfer in the field of antibody engineering and production is currently conducted between PPD and End-User.

NATO Consultant : N/A

Other Collaborating Institutions :

N/A during the reporting period.

Intellectual Property (IP) Rights :

No patent application was made during the present reporting period.

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## New Inhibitors of Botulinum Neurotoxins

Project Co-Directors: Dr. Sina Bavari, United States Army Medical Research Institute of Infectious Diseases, Section Chief, Fort Detrick, Frederick, MD 21702, U.S.A. (NPD)  
Dr. Bogdan Šolaja, University of Belgrade, Faculty of Chemistry, 11158 Belgrade, Serbia (PPD)  
Dr. Rick Gussio, National Cancer Institute at Frederick, Principle Investigator, Frederick, MD 21702, U.S.A. (Co-Director)  
Dr. James Burnett, SAIC-Frederick, Inc., National Cancer Institute at Frederick, Senior Scientist, Frederick, MD 21702, U.S.A. (Co-Director)  
Dr. Dejan Oспенica, University of Belgrade, ICTM-Department of Chemistry, 11158 Belgrade, Serbia (Co-Director)

Approval Date: 27 November 2009  
Effective Starting Date: 1 August 2010  
Duration: 3 years, until July 2013  
NATO Budget: EUR 275,000

### Abstract of Research

Botulinum neurotoxins (BoNTs), enzymes that are the causative agents of the disease state botulism, are considered highest priority (category A) biothreat agents by the CDC. There are currently no drugs to counter the deadly flaccid paralysis mediated by these enzymes post-neuronal intoxication. An act of bioterror employing these toxins would result in high mortality rates, public panic, and major social disruption. Moreover, because individuals intoxicated by BoNTs would most likely seek medical attention only after symptom manifestation, intensive care, mechanical respiration would be required to save their lives. This is not a feasible option given both the limited number of mechanical respirators available and the financial impact that would be incurred. Hence, this research addresses this security issue by developing 'drug-like' small molecule, non-peptidic, inhibitors (SMNPIs) as therapeutic countermeasures that will rescue intoxicated victims, as well as serve as prophylactics, thus providing NATO, its Partners, and its Mediterranean Dialogue Partners with a defense against this bioterror agent.

Secreted by anaerobic spore-forming bacteria *Clostridium botulinum*, BoNTs are composed of a heavy chain (HC) and a light chain (LC), which are linked by a disulfide bridge. Heavy chain function involves transporting the LC into the neuronal cytosol. The LC (also referred to as the catalytic domain) is a Zn metalloprotease that cleaves SNARE (soluble N-ethylmaleimide-sensitive factor attachment protein receptor) proteins. SNARE proteins mediate the exocytosis of neurotransmitter containing vesicles.

The scientific research within this project focuses on translating our existing SMNPIs of the BoNT serotype A LC (BoNT/A LC) into bioavailable, nM range therapeutic candidates. The study also focuses on the discovery and development of SMNPIs of the BoNT serotype B LC (BoNT/B LC) as therapeutic candidates. Finally, we will also cross examine all SMNPIs of the BoNT/A LC and the BoNT/B LC against one another, as well as against the BoNT serotype E.

### Major Objectives

- Optimize *in vitro* BoNT/A LC inhibitory activities of our lead SMNPIs.
- Inhibit BoNT/A LC activity in a primary neuronal cell culture.
- Evaluate SMNPIs of the BoNT/A LC in a murine model.
- Identify and develop SMNPIs of the BoNT/B LC that are efficacious in neurons, and if time permits, in a mouse model.
- Examine all SMNPIs for broad spectrum activity and promiscuity.

### Overview of Achievements since the Start of the Project until 10 October 2011

The main project goal is to translate lead SMNPIs of the BoNT/A LC and BoNT/B LC into bioavailable, nM range inhibitors that will serve as drug candidates, and to discover novel BoNT/E LC SMNPIs.

**PPD:** Synthesis, full chemical characterization, analytics and medicinal chemistry accomplishments (including PBMC toxicity), drug development.

**NPD:** BoNT related screening (*in vitro*, in cells, and *in vivo*), molecular modeling, interactive pharmacophore optimization according to our research paradigm, and drug design.

**NPD & PPD:** Analysis of the biological/synthesis results, SAR analysis.

- We are accomplishing this milestone using a pharmacophore-based approach that incorporates

- Of the chemotypes proposed for this project, a number of azachrysene inhibitors were prepared, since a 1,7-diaminoalkyldiazachrysene-based (1,7-DAAC)-based small molecule was previously identified as an inhibitor of the botulinum neurotoxin serotype A light chain (BoNT/A LC) metalloprotease. The compounds were tested *in vitro* against BoNT/A LC and all of them were potent inhibitors. Eight were more active than our lead structure (BoNT/A LC; 64-72% inhibition); they exhibited general non-toxicity (RAW 267.4 cells).
- Aminoquinoline(AQ)-based thiophene-derived compounds were tested against the BoNT/A LC *in vitro*, and all were found to be moderate inhibitors (30-63% at 20  $\mu$ M). Aqs with phenyl substituents on thiophene ring are more potent inhibitors than corresponding furan derivatives. ACQ-thiophene derivatives were tested for toxicity against the RAW 264.7 (mouse macrophage) cell line, and exhibited general non-toxicity (IC<sub>90</sub> ~ 15,000 nM, average 23 entries).
- As a result of ongoing collaboration between the NPD and PPD, the pharmacophore for BoNT/A LC inhibition was refined using the three-dimensional (3D) superimpositions of synthesized SMNPIs with AQ inhibitor chemotypes. The obtained results support our 4-Zone pharmacophore model, which unites our diverse SMNPI chemotypes in a rational model for developing more potent derivatives. This includes our lead AQ BoNT/A LC inhibitors and antimalarial chloroquine.
- As a consequence, bis-quinoline-sibstituted triophenes have been developed. Compounds of this new chemotype inhibited the BoNT/A LC (at 20  $\mu$ M) by >90%. Determination of inhibitory constants revealed that these SMNPIs are effective in the nM range ( $K_i$ =882-247 nM). The most active compound ( $K_i$ =184 nM) is >40 times as active as our previous inhibitors(1,7-DAAC) and falls within 2-3 of the most active BoNT/A LC inhibitors ever reported.
- The synthesis (and screening) of other BoNT/A LC inhibitors of other chemotypes is underway.
- The screening of prepared diazachrysenes revealed new activity of this chemotype class: inhibition of BoNT/B LC *in vitro*. New chemotype that inhibits BoNT/B LC has been found: acridine-functionalized steroids inhibited both BoNT/A LC and BoNT/B LC by 52-58%, and expressed relatively low activity against generic proteases such as trypsin, thermolysin and papain.
- Newest results with discovery of acridine-functionalized steroids as BoNT/B LC inhibitors indicate that our paradigm of screening all new developed chemotypes/compounds against all three, BoNT/A LC, BoNT/B LC, and BoNT/E LC is optimized to enable the identification of a candidate for development as a broad spectrum SMNPI(s).

Payments through NATO Funds: EUR 152,242

#### Milestones for the Next Six Months

- Continue the development of BoNT/A LC SMNPIs, *in vitro* efficacy evaluation, initial *in vivo* evaluation.
- Develop novel acridine-functionalized steroids as BoNT/B LC inhibitors.
- Insure that all BoNT LC SMNPIs are not promiscuous.
- Continue improving our pharmacophore models.
- Test BoNT SMNPIs in a PBMC toxicity assay, and examine protective activity in motor neurons.

#### Implementation of Results

Data resulting from pre-exposure and post-exposure *in vivo* BoNT/A and BoNT/B challenge studies conducted during this project will be used to provide SMNPI efficacy dose ranges for preliminary toxicity and pharmacokinetics studies, leading to further evaluation for exploratory investigational new drug (IND) studies with the support of the NPD and the PPD. We will seek to partner with a variety of NATO, US, and Serbian National Departments and Ministries.

#### Other Collaborating Institutions

- Health-Authority End-user: Prof. Vladimir S. Kostić, Chair, Institute of Neurology Clinical Center of Serbia, Dr Subiotića 6, 11000 Belgrade, Serbia, and Professor of Neurology, Institute of Neurology, School of Medicine.

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Abbreviations: ADMET = absorption, distribution, metabolism, excretion, and toxicity; BoNT(s) =botulinum neurotoxin(s); BoNT/A = botulinum neurotoxin serotype A; BoNT/A LC = botulinum neurotoxin serotype A light chain (a zinc metalloprotease); HC = heavy chain; HPLC = high performance liquid chromatography; HTS = high throughput screening; IC<sub>50</sub> = inhibitor conc. that reduces the enzyme's activity by 50%;  $K_i$  = an inhibitor constant that is indicative of how potent an inhibitor is; LC = light chain (metalloprotease component of the BoNT holotoxin); mAbs = monoclonal antibodies; PBMC = peripheral blood mononuclear cells; SAR = structure-activity relationships; SMNPI(s) = small molecule, non-peptidic, inhibitor(s); SNAP-25 = synaptosomal-associated protein of 25kDa; SNARE = soluble N-ethylmaleimide-sensitive factor attachment protein receptor; VAMP = vesicle-associated membrane protein; 3D = three-dimensional; 4,7-ACQ = 4-Amino-7-chloroquinoline

SfP 983510

## **GEPSUS-Geographical Information Processing for Environmental Pollution-Related Security with Urban Scale Environments**

Project Co-Directors: Dr. Raffaele De Amicis, Fondazione Graphitech, Trento, Italy (NPD)  
Prof. Radovan Stojanovic, Univ. of Montenegro, Podgorica, Montenegro (PPD)  
Mr. Doron Elhanani, EMESCO, Ha-Ayin, Israel  
Dr. Andrej Skraba, University of Maribor, Kranj, Slovenia  
Mr. Simon Berkowicz, Hebrew University of Jerusalem, Jerusalem, Israel

Approval Date: 3 December 2010  
Effective Starting Date: 3 March 2011  
Duration: 2.5 years, until September 2013  
NATO Budget: EUR 269,000

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Information about the SfP Project through Internet: <http://www.graphitech.it/gepsus>

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### Abstract of Research

Planning on how to handle acute crises at the urban scale caused by exceptional pollution levels or pollutants released during a terrorist attack within an urban environment is of key importance to deploy adequate response measures. GEPSUS tackles the emerging need for new IT technologies, improved preparedness, decision-making support, and adequate management of disasters where exceptional pollution levels may appear in or near urban, densely populated areas. Planning on how to handle acute crises at the urban scale caused by such pollution episodes, as well as by pollutants released due to a terrorist attack within an urban environment, is of key importance to carry out suitable responses.

The case studies tackled by GEPSUS will be located in the area of Podgorica, Montenegro. For **Montenegro**, the social relevance of providing tools to face air pollution crises is significant. According to governmental data sources, from 1991 to 2005 the area of Zeta has been affected by a significant 30% loss in soil fertility due to pollution caused by the nearby KAP plant. The University of Montenegro will develop mathematical simulation models of air pollution dispersion. The developed models will be based on acknowledged modelling methodologies such as Lagrangian dispersion model, Box model, Eulerian model and Dense gas model assuming point and lateral release of pollutants in the area. The impact of modelling and simulation tools is very high both in social and economic terms as the availability of simulation and training tools can potentially save lives and property, with specific regard to the countries involved in GEPSUS.

### Major Objectives

GEPSUS intends to develop a novel IT system capable of simulating the effects of the distribution of air pollutants within an urban environment. The following approach will be followed:

- The lead partners from the University of Maribor and University of Montenegro will foster scientific research in the field of sensing and modelling of environmental factors at the urban scale.
- Concurrently the Hebrew University of Jerusalem partner will provide the aforementioned partners with guidelines related to local-climate and topo-climate controls of air movement/stability.
- The results will be integrated within an existing web-based IT infrastructure for environmental control and management, already developed by Fondazione Graphitech, which is based on open interoperable standards as defined by the OGC and INSPIRE EU directive.

This will ensure that results of the simulation will be readily deployed and tested by the final users (Ministry of Defence of Montenegro) with the support of EMESCO.

In order to study and improve aeration conditions of an urban area GEPSUS will:

- Evaluate existing scientific and practical experience in the evaluation of pollutant spread according to aeration conditions, outlining significant effects on local climate and microclimate landscapes caused by urban settings.
- Adapt the most suitable model for Podgorica to simulate the influence on dispersion of pollutants using factors such as building distribution and configuration, street layout, predominant weather conditions, energy balance, etc. Specific attention will be paid to modelling how the distribution of pollutants can be affected by urban layouts and by local to micro-level winds.

To improve sensing technologies and an early warning system, GEPSUS will develop:

- A mathematical model of sensor architecture and their outputs for various pollutants and explosives (University of Montenegro).
- An algorithm to be developed by the University of Maribor for clustering self-learning examples based on the principle of similar events, results and users' specifications.

GEPSUS will be adopted as a training tool by the Montenegrin Ministry of Defence.

#### Overview of Achievements since the Start of the Project until 19 October 2011

- WP1 has been completed, the user requirements have been defined in detail, and the technical specifications within comprehensive software architecture has been delivered.
- Several existing mathematical models for air pollution dispersion are improved and adapted to the need of the project. Those are developed as software as well as several others software for communication with existing models and displaying threat zones and other instruction on standard geobrowser. Developed software/routines are tested on real cases.
- The scheme and hardware requirements in order to issue the international bid for the procurement activities for Montenegro have been defined, also the code of conduct for issuing the international bid has been agreed upon.
- The publication and dissemination activities for GEPSUS have been very intense and many future opportunities for new collaboration have been realised in the scientific community.

Payments through NATO Funds: EUR 22,859

#### Milestones for the Next Six Months

- Design the Data Centre.
- Training of MoD personnel of Montenegro to use the tools for monitoring.
- Modelling phase.
- Defining the decision-support system.

#### Implementation of Results

The first implemented results include selection of a mathematical model to define threat zones, including exact concentration levels, threat classes and geo-location.

The system will be installed and managed directly by trained personnel of the MoD of Montenegro, who will be able to work with specific monitoring software in the field of air pollution dispersion.

The hardware architecture used will be based on parallel processing in order to provide timely results to the rescue crew, which is of vital importance. One must note that the developed system is a near-real-time system.

#### Other Collaborating Institutions

- ISPRA (Istituto Superiore per la Protezione e Ricerca Ambientale), Italy.
- Trentino Civil Protection Agency, Italy.
- Emergency protection centre of Podgorica, Podgorica, Montenegro.

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Abbreviations: ALOHA: Areal Location of Hazardous atmosphere; CETI: Centre for Ecotoxicological Research of Montenegro; CIP: Competitiveness and Innovation Framework Programme; DLL: Dynamic-Link Library; EC: European Commission; ERPG: Emergency Response Planning Guidelines; GIS: Geographical Information System; GUI: Graphical User Interface; HMZCG: Hydrological and Meteorological Service of Montenegro; HW: Hardware; KAP: Kombinat Aluminijuma Podgorica; IAC: Inter-Application Communication; ICT: Information and Communication Technologies; IDLH: Immediately Dangerous to Life and Health; LOC: Level Of Concern; LPG: Liquefied Petroleum Gas; MoD: Ministry of Defence; NASA: National Aeronautics and Space Administration; NGO: Non-Governmental Organisation; NOAA: National Oceanic and Atmospheric Administration; NPD: NATO country Partner Director; PPD: Partner country Project Director; SAM: Sequence Alignment/Map; SfP: Science for Peace; SW: Software; TPP: Thermo power plant Pljevlja; UNFPA: United Nations Population Fund; UZN: Real Estate Administration of Montenegro; WCS: Web Coverage Service; WFS: Web Feature Service; WMS: Web Map Service; WP: Work Package; WPS: Web Processing Service

SfP 982620

## **Sahara Trade Winds to Hydrogen: Applied Research for Sustainable Energy Systems**

Project Co-Directors: Dr. William Lawrence, US Department of State, Washington, U.S.A. (NPD)  
Mr. Khalid Benhamou, Sahara Wind Inc., Rabat, Morocco (PPD)  
Dr. Abdelaziz Arbaoui, Ecole Nationale Supérieure des Arts et Métiers, Morocco  
Dr. Khalid Loudiyi, Al Akhawayn University, Ifrane, Morocco  
Dr. Sidi Mohamed Ould Mustapha, Université de Nouakchott, Mauritania  
Dr. Heinz Baues, Ministry of Economic Affairs and Energy, Düsseldorf, Germany  
Mr. Paul Lucchèse, Commissariat à l'Énergie Atomique, Gif sur Yvette, France  
Dr. Engin Türe, UNIDO-ICHET, Istanbul, Turkey

Approval Date: 20 June 2007  
Effective Starting Date: 29 November 2007  
Duration: 4 years, until November 2011  
NATO Budget: EUR 291,000

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Information about the SfP Project through Internet: [www.saharadewinds.com](http://www.saharadewinds.com)

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### Abstract of Research

In order to assess the energy potential of the trade winds, a wind monitoring infrastructure has been installed in Morocco and Mauritania, and is currently recording data on several sites spread over a distance of several thousand kilometers (Safi Morocco to South of Nouakchott). The objective of the project is to prove that intermittent wind energy from the trade winds can be stored in the form of hydrogen. The NATO SfP-982620 applied research project is aimed at assessing integrative processes where access to electricity, wind energy, wind-electrolysis and electrolysis by products utilization can be integrated within regional applications. Two 30 kW Wind-electrolysis laboratory test benches deployed at Morocco and Mauritania's main universities as part of their "green campus concepts" will provide technology evaluation with the support of an industrial network made of the region's telecom, utilities and mining industries. Power supply options utilizing wind generated electricity in distributed as well as integrated industrial applications will be assessed within buildings and industrial complexes where hydrogen storage/electricity restitution using fuel cells for specific applications can be demonstrated.

### Major Objectives

- Installation of Measurement Infrastructure network for the Trade Winds.
- Wind Resource Assessment of the Trade Winds.
- Small wind turbines manufacturing program.
- Deployment of wind-electrolysis and hydrogen storage modules.
- Evaluation of Wind-electrolysis for weak grid stabilization.
- Wind-electrolysis by products integration and value added synergies.
- Wind generated hydrogen as a sustainable energy carrier.
- Wind energy, electrolysis and hydrogen technologies are picked up by the industry.
- Scientists are actively involved with various end user groups.

### Overview of Achievements since the Start of the Project until 30 September 2010

- Signed conventions with End-Users for deployment of Wind Measurement Instruments.
- Installed all Wind Measurement instruments (Morocco & Mauritania).
- Wind-hydrogen Fuel Cell Test benches delivered on all university campus sites.
- Small Wind Turbine industrial engineering program initiated on towers, blades and generators.
- Green campus expansions plans based on current integrated applications underway.
- Applied research and subsequent project proposals on wind generated hydrogen established.

Payments through NATO Funds: EUR 273,547

## Milestones for the Next Six Months

- Collect data of wind measurement program in Morocco and Mauritania.
- Complete installation of Small Wind Turbine-Grid lab system in Morocco (Meknes).
- Pursue installation of small wind turbines green campus concepts in Morocco & Mauritania.
- Install and expand green campus concepts with 30 kW wind-electrolyzer-fuel cell labs with hydrogen storage in Morocco and Mauritania.
- Test green campus systems with wind-electrolyzer-fuel cell equipment (Morocco & Mauritania).
- Pursue small wind turbine manufacturing and outsourcing of parts program using green campus equipment program and meeting end-users needs.
- Pursue wind-electrolysis byproducts research topics.
- Develop student training programs and new curriculums based on Project's themes.
- Prepare final project conference, final report and subsequent follow-up activities.
- Submit subsequent pilot projects proposals at universities and end-users (within SfP Partners).

## Implementation of Results

The universities willingness to pursue the installation of small wind turbines to feed their respective campuses with electricity as part of their green campus concepts shows that the small wind turbine program is successful and goes beyond feeding our electrolyzers in storing intermittent renewable electricity. The setting of the system with good visibility for demonstration in both campuses with industrial scale electrolyzers (30 kW) is likely to draw further interests in the project's outcome. Significant co-funding for the wind-electrolysis test benches provided by manufacturer likely to spur interest and enhance project outcomes at end-user partners. Industrial end-use applications, supported by an effective wind monitoring program in partnership with the telecom operators in Mauritania and Morocco enable applications to be explored with various configurations and electrolysis processes. Likely outcomes are the possibilities to consider the integrated wind electricity processing of iron ore in Mauritania as well as the decentralized wind-electrolysis for hypochlorite production for the water utilities of the region starting with SfP partners. Demonstration through a green corporate headquarter concept and a deployed pilot project site with the water and electric utilities headquarters in Morocco in partnership with UNIDO-ICHET, along with the iron-ore industry of Mauritania will highlight NATO's SfP-982620 project outcomes through successful academia end-user industrial partnerships.

NATO Consultant : N/A

## Other Collaborating Institutions

- Ecole Mohammedia des Ingénieurs, Rabat, Morocco
- ENSET Mohammedia, Morocco
- Faculty of Sciences, Tetouan, Morocco
- Faculty of Sciences, Kenitra, Morocco
- ONEP Office National de l' Eau Potable (Water Utilities of Morocco), Rabat, Morocco
- Maroc Télécom, Rabat, Morocco
- Mauritel Mobiles, Nouakchott, Mauritania
- Institut Supérieur d' Enseignement Technologique ISET Rosso, Mauritania
- APAUS- Agence de Promotion de l' Accès Universel aux Services, Nouakchott, Mauritania
- SAFA- Société Arabe de Fers et Aciers, Nouadhibou, Mauritania
- SNIM- Société Nationale Industrielle et Minière, Nouadhibou, Mauritania

Intellectual Property (IP) Rights : N/A

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SfP 983805

## **Designing Intelligent, Resilient, Scalable and Secure Next Generation SCADA (Supervisory Control and Data Acquisition) Infrastructure (SCADA-NG)**

Project Co-Directors: Dr. Stefano Zanero, Politecnico di Milano, Milano, Italy (NPD)  
Dr. Zdenko Simic, University of Zagreb, Zagreb, Croatia (PPD)  
Luka Lugaric, University of Zagreb, Zagreb, Croatia  
Slavko Krajar, University of Zagreb, Zagreb, Croatia

Approval Date: 27 November 2009  
Effective Starting Date: 17 February 2010  
Duration: 3 years, until February 2013  
NATO Budget: EUR 244,500

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Information about the SfP Project through Internet: [www.fer.hr/NATO\\_SNG](http://www.fer.hr/NATO_SNG)

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### Abstract of Research

The power system as critical infrastructure lays in the fact that it is increasingly essential for functioning of, other critical infrastructures (ICT, hospitals, etc.). Existing complexity has been proved as challenge in order to keep high reliability and safety of the power system, especially in the context of small cities, incorporating smart grids, deregulated energy markets and high utilization of distributed energy sources. Security challenges in this context are extremely high.

Research focus in this project is establishment of simulation platform where all different threats to the power system reliability and security could be investigated. The major goal would be to simplify process of finding better solutions for the optimal system design and sufficient control. This research is based on utilization of state-of-the-art concepts and tools, using real systems operating conditions and inputs, as well as planned developments of the grid in light of global policy changes regarding sustainable development.

### Major Objectives

- Putting future SCADA systems in context of smart cities and smart grids.
- Studying and assessing the current status of SCADA deployment (emphases on Italy and Croatia).
- Assessing priorities in future SCADA testbed architecture specification and development.
- Proposing a novel architecture for SCADA interaction modeling, based on cooperative agent negotiation, to bridge model with increased reliability and security.
- Formally and empirically prove the improvements in security, safety and resilience of this architecture over the ones commonly used.
- Developing a common understanding of industrial needs and requirements regarding the security of control systems and the related standardization, accompanied by a raising awareness programme reaching all end-users.
- Identifying and disseminating best practice, possibly in a joint endeavor between manufacturers and end users, resulting in a increased capability and defined technology taxonomy of security solutions.
- Development and deployment a SCADA testbed platform for analysis of emergent phenomena in power systems.
- Interfacing with similar projects, focusing on smart grids and smart cities.

### Overview of Achievements since the Start of the Project until 10 October 2011

- SCADA-NG Research laboratory is in active use and further development by the project staff.
- Project team and young researchers have selected specific problems to be investigated in details.
- Implementation of functional specification is in progress.
- Implementation of the risk and reliability assessment of the power grid with SCADA is defined and ready for testing.
- Specific simulation models in different platforms are further upgraded and in the process of interactive integration.
- Presentation and publication of project results is continuous.

- Five young researchers stipendiary and five volunteer student researchers have been continuously involved in the project related work.
- SCADA-NG NATO project is major ground base for related student seminars and projects.

Payments through NATO Funds: EUR 99,866

#### Milestones for the Next Six Months

- Integrating different modeling segments together into SCADA tesbed simulator:
  - Renewable energy generation.
  - Smart city power system.
  - Reliability and risk assessment.
- Publication of at least 2 conference papers.
- Smart metering system within a building functioning on premises of FER (University of Zagreb).
- Renewable energy system functioning at premises of FER.
- First complete observations on a real-life smart building functionality.
- Scaling accomplished results with existing SCADA systems in the Croatian Utility Company (HEP).

#### Implementation of Results

Project results will be implemented at the research-education laboratory at the Faculty of electrical engineering and computing at the University of Zagreb.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

#### Intellectual Property (IP) Rights

There are no IP rights for the Project at the moment.

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Abbreviations: SCADA: Supervisory Control and Data Acquisition

SfP 977982

## **Development of an Advanced X-Ray Generator Based on Compton Back-Scattering**

Project Co-Directors: Jan I.M. Botman, TUE, Eindhoven, The Netherlands (NPD)  
Alexander Shcherbakov, KIPT, Kharkov, Ukraine (PPD)  
Andrei Lebedev, Lebedev Institute, Moscow, Russia (Co-Director)

Approval Date: 9 December 2002

Effective Starting Date: 2 January 2003

Duration: 3 years (originally approved); 8 years (revised), until 30 December 2011

NATO Budget: EUR 650,000

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This project has established draft web sites at both the KIPT and SLAC.

The URL of the SLAC page is: <http://ssrl.slac.stanford.edu/nestor>

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### Major Objectives

- Preparation of a Technical Design Report for NESTOR, the Compact Laser-Electron X-ray Source.
- Extend the accelerator physics community's understanding of the simultaneous X-ray generation and laser cooling of an electron beam circulating in a storage ring.
- Development of the X-ray optical and diagnostic systems for the X-ray source.
- Redesign and reconstruction of the storage ring N-100.
- Commissioning of the reconstructed storage ring N-100.

### Overview of Achievements since the Start of the Project until June 2011

- Following consultations with the project co-directors and the KIPT staff, the Compact X-Ray Generator has been given the name NESTOR ("Next-generation Electron STORage Ring")
- The Technical Design Report has been completed and translated in English and after revision was ready in June-August 2007.
- Thanks to continuing financial support from the Ukrainian government and assistance from KIPT's Directorate, repair and reconstruction of the experimental building that will house the NESTOR facility has been completed.
- The development of codes for the dynamics of electron/laser interaction simulations has been completed.
- The high power RF, magnetic, and vacuum system designs for NESTOR facility have been completed.
- Experimental bench for magnetic measurements has been constructed and is in operation.
- The dipole, quadrupole and sextupole magnets for the NESTOR lattice have been fabricated, delivered and tested.
- Advanced getter materials for minimizing the vacuum pressure inside NESTOR have been researched.
- 80 power supply sources for NESTOR electromagnetic system have been designed; prototype has been manufactured and tested.
- NESTOR storage ring RF cavity has been manufactured in BINP Novosibirsk and tested in NSC KIPT.
- Vacuum chambers for bending magnets have been manufactured and tested for leakage.
- The electron linear accelerator injector of 100 MeV has been assembled and tested.
- Injection transportation channel has been assembled, cabled and is ready for testing.
- Survey and alignment system has been designed, developed, tested and is in operation for NESTOR facility alignment.
- Pick-up stations and strip-line assembly have been designed and are under production.
- Inflector for the injection system has been designed and is under production.
- Modulator for the injection system has been designed and is under production in Budker INP, Novosibirsk, Russia.
- About sixty articles in refereed and conference journals have been published.
- 21 senior scientists and 28 young scientists took part in work of international schools and conferences.
- During report period 3 TV programs, 5 journal and 5 newspaper articles concerning NESTOR activity were shown and published.
- Eight outstanding students have joined the project at the KIPT.

### Milestones for the Next Six Months

- January 2011: Preparation of operation permission and radiation safety documents.
- February 2011: Inflector test at KIPT in collaboration with BINP.
- End of February 2011: Completion of design work for optical system. Beginning of purchasing of components.
- End of March 2011: Radiation shield finished for the whole facility.
- End of April 2011: Beam commissioning of beam transfer line. Successful beam transport up to the end of the transfer line.
- End of July 2011: Threading of the electron beam through the fringe field of the first bending magnet and the sextupole and quadrupole magnets before the inflector. Beam reaches successfully the entry of the inflector.
- End of August 2011: Completion of ring vacuum system and installation of the inflector.
- 1 September 2011: Start of beam commissioning of the NESTOR ring.

### Implementation of Results

The primary product of the project will be a beam of intense Compton back-scattering x-rays and synchrotron radiation from bending magnets useful for scientific research and technological or medical applications. To this end contacts have been established and are being maintained with end users who are interested in utilizing NESTOR's light. So far they include:

- the Institute of Solid State Physics, Materials Science and Technologies (Kharkov, Ukraine)
- the Grigoriev Institute for Medical Radiology (Kharkov, Ukraine)
- the L.T. Malaya Institute of Therapy (Kharkov, Ukraine)
- the Institute of Metal Physics (Kiev, Ukraine)
- the Institute for Single Crystals (Kharkov, Ukraine)

### NATO Consultant

A Consultant has been appointed to the project by NATO, Dr. Ernst Wehreter, Senior Scientist, BESSY, Berlin, Germany.

### Other Collaborating Institutions

Contacts with the following institutions have been established:

KEK (Photon Factory); Tsukuba-shi, Japan

NIRS (National Institute of Radiological Sciences); N.Sasao, Chiba-shi, Japan

INP (Budker Institute of Nuclear Physics); Novosibirsk, Russia

LAL (Linear Accelerator Laboratory); Orsay, Paris, France

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SfP 983932

## **Novel Magnetic Sensors and Techniques for Security Applications**

Project Co-Directors: Prof. Marcis Auzinsh, University of Latvia, Riga, Latvia (NPD)  
Prof. Ron Folman, Ben-Gurion University, Be'er Sheva, Israel (PPD)  
Prof. Eugene Alexandrov, Ioffe Physical Technical University, St. Petersburg, Russia (Co-Director)  
Prof. Wojciech Gawlik, Jagiellonian University, Kraków, Poland (Co-Director)  
Prof. Dmitry Budker, University of California, Berkley, U.S.A. (Co-Director)

Approval Date: 6 December 2010  
Effective Starting Date: 3 June 2011  
Duration: 3 years May 2014  
NATO Budget: EUR 650,000

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Information about the SfP Project through Internet: ***To be created***

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### Abstract of Research

In this project we aim to construct a miniature, cheap, robust magnetic sensor that could be extremely useful for a wide range of applications ranging from medicine to public safety. For example, such magnetic sensors could form the base for heart and brain scanners. They could also form the base for detecting bombs in airports, either by detecting their magnetic signature, or by the sensing, through nuclear magnetic resonance methods, of trace amounts of chemicals. In the latter mode, these sensors can also help in the detection of chemical or biological hazards. Another example for a possible use of such sensors would be to detect structural damage (e.g. micro cracks) in metallic structures such as jet engine blades or bridges after an earthquake.

### Major Objectives

- The detection of ordnance and explosives.
- Non destructive imaging of microscopic features to identify structural damage in essential equipment.
- Detection of trace quantities of dangerous chemical and biological materials.

Detailed objectives:

- Elucidating the fundamental properties of the nitrogen-vacancy (NV) color centers in diamond, including understanding the structure of the singlet states and various T<sub>1</sub>, T<sub>2</sub>, and T<sub>2</sub><sup>\*</sup> relaxation mechanisms in the system.
- Development of a robust magnetic sensor based on infrared absorption in NV diamond.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Production of a microstructure for the magnetic microscopy of superconductors using diamond sensor. The structure is composed of a micro-pattern of the superconducting material deposited on MgO substrate and a diamond sample on which a thin nano layer of nitrogen-vacancies (NV) centres is implanted.
- Magnetic sensing of a random magnetic field with a resolution of ~100 nT. The sensing is done by scanning the microwave resonance of the NV centre ground state which is magnetically sensitive. The high accuracy is attributed to the use of the lock-in technique which produces a derivative signal of the resonance. Such a magnetic sensitivity is suitable for the imaging of vortices in superconductors which we intend to conduct in the following year.
- The collaborative work on T<sub>1</sub> relaxation is approaching completion.
- Investigation of the light narrowing effect is in progress at Berkeley.
- Preliminary studies of thin (10-100 micrometer) diamond films revealed signatures of NV color centers.

There have been a number of exchanges supported by the project:

- Berkeley undergraduates Maria Simanovskaya and Geoffrey Iwata to Krakow and Riga.
- Krakow Graduate student Daniel Rudnicki to Berkeley (visit in progress).

- Ioffe Physical Technical Institute representative Dr. Alexandra Soltamova (SPB) to Berkeley for a month (visit in progress).
- Ben-Gurion University representative Amir Waxman to Berkeley.
- University of Latvia representative Dr. A. Jarmola to Berkeley.

Payments through NATO Funds: EUR 37,500

#### Milestones for the Next Six Months

- Submit publication on T1.
- Begin investigating optical resonators of different types.
- Submit publication on light narrowing.
- Prof. Auzinsh will visit Berkeley for a week.
- Sub wavelength resolution (~50nm) magnetic detection of thin layer samples.
- Magnetic detection of superconducting vortices.

#### Implementation of Results

The Berkeley team is heading the cooperation of the project implementation teams with the industrial partner - *Southwest Sciences* (Ohio Operations, 6837 Main Street, Cincinnati, OH, USA) – represented by Dr. C.Hovde, regarding the commercialization of the project results.

NATO Consultant: N/A

#### Other Collaborating Institutions

Some further cooperation is underway to be implemented during upcoming periods.

Intellectual Property (IP) Rights: N/A

SfP 981883

## **The Protection of the Gulf of Aqaba from the Anthropogenic and Natural Stress in the face of Global Climate Change**

Project Co-Directors: Dr. Dilek Ediger, TÜBİTAK MRC, Gebze-Kocaeli, Turkey (NPD)  
Dr. David Iluz, Bar-Ilan University, Ramat Gan, Israel (PPD)  
Dr. Tariq Al-Najjar, University of Jordan, Aqaba, Jordan  
Prof. Levent Bat, University of 19 Mayıs, Sinop, Turkey

Approval Date: July 2006  
Effective Starting Date: January 2007  
Duration: until December 2011  
NATO Budget: EUR 264,000

### Abstract of Research

The aim of our study is to characterize the effects of dust and of anthropogenic inputs on the structure and function of the phytoplankton assemblages of the Gulf of Aqaba. The study is divided into two parts, one conducted in the field, and another in the laboratory. In the field, changes in the size distribution and gross taxonomic composition of phytoplankton and changes in the spectral properties of the water column following dust storms and nutrient status were determined. In the laboratory, the effects of dust storms and of nutrients leached from it on natural Gulf phytoplankton samples and on representative species are being studied. All optical *in situ* measurements will be analyzed against contaminant satellite spectral images. The bio-optical data, dust inputs and nutrient gradients will be integrated into a predictive simulation model describing likely trends in the development of the pelagic phytoplankton in the gulf under different scenarios regarding anthropogenic and dust-borne inputs.

### Major Objectives

- Establish a cooperation between Israel, Jordan and Turkey in marine sciences.
- Establish quantitative relationships between water optics and water quality.
- Correlate algal pigment composition with gross taxonomic structure of phytoplankton.
- Phytoplankton pigmentation and photosynthetic efficiency will be related to photosynthesis and quantum yield, and how these are affected by nutrients, pollutants and dust.
- Satellite spectral images will be compared with the 30 years of available historical images.
- A simulation model predicting present and future ecosystem processes based on historical data and data from the proposed project will be constructed as a tool for management of Gulf of Aqaba.

### Overview of Achievements since the Start of the Project until October 2011

- Monthly cruises were started in both sides of the Gulf of Aqaba. Jordan and Israel site sampling were finalized in January 2009 and October 2010 respectively.
- Cultures of single phytoplankton species were initiated. On the cultures, photosynthesis versus energy relationships, nutrient and iron conditions, growth rates, cell numbers and of chlorophyll concentration were determined.
- 7 graduate students (Amir Yamshun, Efrat Shaham, Gal Dishon, Razy Hoffman from Israel, Fatih Şahin from Turkey, Ayman Jamal and Mustafa Alshabi from Jordan) have started to work in this project.
- Experiments on cultures of single phytoplankton species were done to observe the dust effect on the cultures' photosynthesis versus energy relationships.
- Phytoplankton samples were collected from Aqaba Bay during cruises analysed under microscope.
- Surface mesozooplankton in terms of abundance and composition were analyzed by Dr. Mohsen from Suwis Canal University (Egypt).
- Pigment samples which were collected from Aqaba Bay during some cruises were analyzed using HPLC in TÜBİTAK MRC laboratory.
- All data started to be combined for a simulation model predicting present and future ecosystem processes, and work on optic based model in pelagic and coastal waters of Aqaba Bay.
- The scientific results obtained from this project activities are published in various ways.

- Solar irradiance sensor was positioned on IUI pier, set spectral calibration factors for clear, cloudy and dusty weather conditions. And spectral surface irradiance estimated at 10 min resolution.
- Workshop about the rising of our knowledge about the environmental problems and the role of governmental and nongovernmental societies in protection of the Gulf waters. April 2010, Aqaba, Jordan.
- Scientific Workshop in Aqaba related with current status of all projects funded by NATO SPS programme in the Area.
- The Jordanians participated with NGOs in the activities of the Earth Day of 2011.

Payments through NATO Funds:            EUR 230,790 EUR

#### Milestones for the Next Six Months

- Submission of the final report (April 2012).
- Joint meetings are planned with Israeli and Jordan scientists in Turkey during January 2012.
- Joint meeting with end-users is planned in both Jordan and Israel.
- To continue working on the model of gulf of Aqaba.
- To generate multilingual community outreach materials (Videos, CDs, pamphlet and educational publications).
- Writing joint papers.

#### Implementation of Results

-To provide end users with a model allowing interpreting changes in bio-optical parameters and in structure of plankton assemblages as warning signals calling for corrective action- or providing proof of success of such measures.

-To establish a permanent Jordanian-Israeli task force focusing on the protection of Gulf of Aqaba Ecosystems.

-To generate Multilingual community outreach materials (Video, CDs, pamphlet and Educational publications) aimed at enhancing public appreciation of the Gulf's unique life and generate pressure for their preservation for posterity.

#### End-users

Dr. Salim Al Mugarby Aqaba Special Economic Zone Authority, Jordan; Dr. David Zakai Nature and Parks Authority, Jerusalem, Israel; Ran Amir, Director MCED, MoE Gulf of Aqaba Marine Ecologies Ministry of the Environment, Unit for Prevention of Marine Pollution.

#### NATO Consultant

Prof. Anatoly Gitelson-remote sensing  
University of Nebraska Lincoln, U.S.A.

#### Other Collaborating Institutions

Zvy Dubinsky Bar-Ilan Univ. Ramat Gan Israel, Ahmed Kideys Black Sea Commission, Turkey  
Dr. Luca Palmieri, Dept. of Chemical Processes Engineering, University of Padova, Italy  
Dr. Kamenir Yury, Faculty of Life Sciences, Bar-Ilan Univ. Ramat Gan Israel

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SfP 982161

## **Monitoring Natural and Anthropogenic Aerosol Pollution and its Impact on Ecosystems in the Gulf of Aqaba**

Project Co-Directors: Dr. Adina Paytan, UCSC, Santa Cruz, California, U.S.A. (NPD)  
Dr. Arnon Karnieli, Ben Gurion University, Ber Sheva, Israel (PPD)  
Dr. Tariq Al-Najjar, Marine Science Station, Aqaba, Jordan (Co-Director)  
Dr. Anton Post, Hebrew University, Jerusalem, Israel (Co-Director)

Approval Date: 12 July 2006  
Effective Starting Date: 1 January 2007  
Duration: 5 years, until December 2011  
NATO Budget: EUR 275,000

### Abstract of Research

The Gulf of Aqaba, in the Middle East, is a prime tourist destination attracting hundreds of thousands of tourists annually who come to Egypt, Israel, Saudi Arabia and Jordan to enjoy the warm sunny beaches, majestic mountains, cobalt blue waters and spectacular coral reefs. Protection of the natural resources of the Gulf are therefore vital for the local economy and the preservation of fish, corals and other organisms and their habitat as well as the water quality and purity is of major concern. The economic and national security of the nations surrounding the Gulf depends on these resources. However, one of the most devastating and wide spread threats to environmental security that many countries in the world are facing is the degradation of local and global ecosystems. The Gulf's water and its natural marine ecosystems, including the coral reefs, are impacted by various sources of pollution, and specifically air borne dust pollution, which may threaten their quality and diversity. The major objective of this research project is to quantify the natural and anthropogenic nutrient and trace metal pollution to the Gulf, to identify their sources and to assess their impact on ecosystem structure and function in the Gulf of Aqaba. This is a multidisciplinary collaborative project between remote sensing scientists, marine biologists, marine chemists and atmospheric scientists where state-of-the-art techniques are applied to quantify and evaluate the impact of natural and anthropogenic pollutants on the natural ecosystems in the Gulf of Aqaba. We hope that the results will be used by planning and environmental protection agencies from countries surrounding the Gulf for conservation of this valuable and sensitive ecosystem.

### Major Objectives

Work proposed here will result in quantitative estimates of atmospheric input of natural and anthropogenic constituents including nutrients, trace metal and other pollutants to the Gulf of Aqaba, will determine the fate of these pollutants within the system and the impact they have on the natural marine ecosystems. To accomplish this we will integrate field, laboratory, modeling, and remote sensing data processing approaches. Products will be transferred to the end-users, the ministries of environment of Israel and Jordan, for decision making and improving the managements of the Gulf environment. Specifically, a coupled physical-chemical-biological model which includes aerosol deposition will be available for assessing risks related to potential changes in aerosol deposition or composition.

### Overview of Achievements since the Start of the Project until April 2011

- A study on the nitrogen dynamics in the Gulf of Aqaba and in particular the causes of the nitrite maximum in the water column with emphasis on seasonal dynamics and the roles of light, substrate and community structure.
- Investigating the slow solubility of phosphate from aerosols and the impact of anthropogenic deposition of phosphate on phytoplankton.
- Refining the use of aerosol optical thickness to detect dust storm events.
- Validating remote sensing technologies for monitoring reef change.
- Conduct seasonal study of cyanobacterial diversity with a focus on succession patterns in surface waters (0-20m) following the annual *Synechococcus* spring bloom.
- Monitoring toxic metal levels in two fish species.

Milestones for the Next Nine Months

- Finish evaluating the remote sensing aspects.
- Finalize and test the coupled regional model.
- Preparation of Final Report.
- Communicating with the end-users.
- Data will be presented in additional international meetings.
- Additional papers will be published in scientific journals (so far over 19 manuscripts published).

Implementation of Results

Results and reports will be made available to end users (Dr. Bilal Bashir, Special Economic Zone Authority, Aqaba, Jordan and Mr. Ran Amir, Ministry of the Environment, Haifa, Israel). We have started working on a conceptual ecosystem model which will consist of the final product to be utilized by the end-users within a year of project completion.

NATO Consultant

Prof. Nikolaos Mihalopoulos, Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, Heraklion, Crete, Greece.

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SfP 982481

## **Demonstration of a Novel High Recovery Desalination Process for Brackish Groundwater**

Project Co-Directors: Prof. Alan R. Greenberg, University of Colorado, Boulder, U.S.A. (NPD)  
Dr. Jack Gilron, Ben Gurion University, Beer Sheva, Israel (PPD)  
Prof. Mousa Mohsen, Hashemite University, Zarqa, Jordan (PPD)  
Dr. Kholoud Mashal, Hashemite University, Jordan

Approval Date: 20 June 2007

Effective Starting Date: 1 January 2009

Duration: 3 years, until 31 December 2011

NATO Budget: EUR 293,000

### Abstract of Research

Desalination is a well-established process that uses reverse osmosis (RO) for the removal of salt from seawater or other brackish (salt-containing) water sources. RO is a pressure-driven process in which water is forced through a polymeric membrane while salts are retained. A major barrier to efficient desalination processes is the potential for the precipitation by sparingly soluble salts on the surface of the membrane, a process termed scaling.

The project focuses on the development and building of demonstration desalination pilot plants based on RO that would operate in Jordan and Israel on brackish groundwater. These plants will be set up to extract 90-95% of the groundwater as product water thereby generating ~50 m<sup>3</sup> per day of product water. In RO the feed stream is split into a product stream that passes through the membrane and a smaller reject stream (retentate) at much higher concentration containing the rejected salts. To reach high recoveries many membrane elements are connected in series so the reject stream from one element becomes the feed stream for next element in the series and so on. By the time the reject stream leaves the last membrane element, it is so concentrated that scaling is likely. Scaling is of immense practical importance since it significantly degrades membrane performance and/or water quality and hence increases the cost of desalination.

The innovation in this work is to prevent scaling by exploiting the fact that there is an induction time between reaching supersaturation and the start of scaling. In the proposed approach the direction of flow is reversed before the induction period is complete so feed is directed to the concentrate end and concentrate leaves from the feed end. Innovative valving will allow flow reversal (FR) in tapered flow (TF) arrangements that involve reducing the number of membrane elements in the direction of the retentate flow in order to ensure flow rates that minimize the potential for membrane scaling. The flow-reversal methodology is based on technology developed at Ben Gurion University (BGU). The induction time will be monitored in situ by using ultrasonic sensors developed by the NSF Center for Membrane Science, Engineering and Technology (MAST) at the University of Colorado (CU) in order to initiate the flow reversal. Training of participating personnel from BGU, CU and Hashemite University (HU) will enable integration of these technologies at the pilot level and in field tests that involve Mekorot Water Company (MWC) and Water Authority of Jordan (WAJ). If successful, this new sensor-based separation process would significantly lower the cost of brackish water desalination.

The Middle East is plagued by a severe scarcity of fresh water sources, and so seawater has been the most commonly used raw water source for desalination. By exploiting brackish groundwater to such a high degree and reducing brine volumes, these demonstration plants will encourage development of these additional marginal water sources in Jordan and Israel. Such development will relieve pressure on existing water sources thereby reducing friction and facilitating cooperation between countries of the region to cope with dwindling freshwater supplies so that water scarcity will not become a driver of future conflict between nations in the Middle East.

### Major Objectives

The major objectives of this project include:

- Develop a method for high recovery brackish water desalination by flow reversal that will allow reduction of brine disposal costs by 25-50% and enable 5-10% of additional feedwater recovery for savings of \$0.05-0.1 per m<sup>3</sup> of product.
- Demonstrate the effectiveness of the method at a site in a Middle Eastern country with saline groundwater resources that is water-challenged.
- Show that flow reversal can be effective in increasing recovery in tapered-flow (TF) RO systems.
- Demonstrate that ultrasonic sensors can be effectively used to trigger the timing for flow reversal and that they are sufficiently robust for use in typical field/plant conditions.

- Obtain a commitment by end-users to install such devices in one or more future desalination projects.

#### Overview of Achievements since the Start of the Project until 31 March 2009

- A Jordanian site where the RO unit will be tested: three locations are currently under consideration.
- Flat-sheet flow cell with integrated acoustic sensors has been assembled.
- Initial results obtained from flat-sheet flow cell using prototype signal-analysis methodology.

#### Overview of Achievements from April 1 until 30 September 2009

- Initial results indicate that real-time data from sensors compares well with data from independent measurements obtained at test completion.
- The first combined tapered-flow manifold and RO unit has been designed and ordered.
- A Jordanian site at which the second RO unit will be tested has been selected and approved.
- First proof-of-concept results obtained for a bench-scale NF flow cell operating in flow reversal with ultrasonic sensors.
- Designed and fabricated a flat-sheet RO flow cell with integrated acoustic sensors that will be used for comprehensive testing of sensor-controlled flow reversal.

#### Overview of Achievements from October 1 until 31 March 2010

- Set-up of TF RO pilot equipped with 4-inch SWM elements.
- Initiating of Testing at Sde Boker of first US-operated TF-FR unit on synthetic and well water.
- Initiation of water-quality monitoring at site of Jordanian RO unit.
- Successful operation of bench-scale flat-sheet membrane module operating in flow reversal under control of ultrasonic sensors.

#### Overview of Achievements from April 1 until 30 September 2010

- Successfully tested the tapered flow, flow-reversal pilot plant on synthetic (calcium carbonate) waters at 85-88% recovery with exit Langelier saturation index of 1.5 (30 X saturation) in closed-loop operation.
- Successfully tested Mashabe Sadeh well water with recovery of 88% in closed-loop operation. All of this was done without the use of antiscalants.
- The open-loop (once-through) operation on Mashabe Sadeh well water was initiated at 85% recovery after appropriate preparations were made.
- During the course of testing, effective solutions were found to allow keep the concentrate line downstream of the membrane flow reversal valve manifold free of scaling. This is important as the downstream concentrate line constantly was exposed to supersaturated solution until the effective solution were implemented.
- Mekorot (end-user) has invested in the technology and expressed interest to participate in a retrofit project to incorporate TF-FR in an existing desalination plant.
- Developed a novel and powerful methodology for analysis of real-time scaling and corresponding control of the switch in flow direction for bench-scale flat-sheet module.
- The proof-of-concept results based on this methodology enabled a provisional patent to be filled in July 2010.
- Results of this work were presented at two major international membrane meetings in July and October, respectively.
- Design and assembly of a RO system incorporating a 4-inch spiral-wound module is underway at CU.

#### Overview of Achievements from October 1 until 31 March 2011

- Testing at Sde Boker of TF-FR unit in open loop on Mashabe Sadeh Well water.
- Testing of first TF-FR unit at field site of Mekorot at Sabha in open loop with increased recovery and reduced antiscalant.
- The flat-sheet US hardware/software was successfully operated to trigger flow reversal at the BGU site.
- Arrangements completed for the delivery of the pilot-scale RO facility to Zarqa, Jordan.
- New hardware/software developed at CU that enables automatic operation of ultrasonic sensor-controlled flow reversal with improved sensitivity in a flat-sheet system.
- Completion of design and assembly of an RO system incorporating a four-inch spiral-wound module (SWM); initial design of mechanism for coupling ultrasonic sensors to SWM surface.

#### Overview of Achievements from April 1 until 30 September 2011

- BGU has successfully run the flow reversal pilot at Mekorot's pilot facility at Sabha near Eilat, increasing recovery from 75% to 84% and reducing antiscalant consumption by 50%, from 4 mg/L to 2 mg/L.

- BGU has successfully demonstrated the feasibility of using ultrasonic sensors and software developed at CU for detecting (for the first time) the threshold of calcium carbonate scaling and successfully has used the signals for triggering flow reversal.
- The pilot plant ordered by HU for its site has been completed; based upon experience gained from the operation of the BGU pilot, this new pilot has incorporated significant improvements.
- CU has developed new hardware/software that enables automatic operation of ultrasonic sensor-controlled flow reversal with improved sensitivity in a flat-sheet system.
- CU successfully demonstrated (for the first time) early warning sensing of the onset of calcium sulfate scaling in a 4-inch spiral wound module.

Payments through NATO Funds: EUR 205,016

#### Milestones for the Next Months

- Demonstrating at Sabha of methods for keeping concentrate line clean.
- Testing of temperature compensation for ultrasonic sensors (US) in real pilot environments.
- Testing of U/S unit for detecting silica.
- Technical training of Jordanian team on the second RO pilot plant in Israel.
- Delivery and installation of second pilot at Jordanian site and initiation of field-testing.
- Provide specifications for and assist with the installation of ultrasonic sensors on the pilot-scale RO unit in operation in Israel.

#### Implementation of Results

A full patent application describing the new technology was filed in July 2011.

An agreement has been made between Mekorot Water Company and a company set up to commercialize the flow reversal (ROTEC Ltd.) to perform a retrofit of an existing desalination plant at Maagan Michael with the capacity of 1200 m<sup>3</sup> per day being operated by Mekorot. The Israel Ministry of Trade and Industry will help provide funding for this effort. This agreement has now been signed and the PID has been completed. The order has been placed with Nirosoft Ltd. The retrofit will increase recovery from 80% to 92% and would result in an additional 180 m<sup>3</sup>/day of product if implemented on the whole plant. It is presently being implemented on 60% of the plant in order to be able to compare the two options.

In addition, a water-treatment process company and private individuals are close to investing in ROTEC Ltd. to help it develop its products for market. Moreover, two major multinational corporations have expressed interest in testing flow reversal for various projects through ROTEC Ltd.

Completion of testing on flat-sheet module has confirmed the ability to implement the first-ever smart system whereby multiple cycles of flow reversal are automatically controlled by the ultrasonic sensors. In addition, initial proof-of-concept regarding adaptation of the technology to 4-inch spiral-wound modules. While technical progress has been extensive, the rate and extent of additional technical development has been somewhat slowed due to lack of resources to support the considerable personnel time and effort required.

Independently Prof. Greenberg and Dr. Gilron are giving extensive lectures at a number of national and inter-national conferences; the work has attracted attention. One manuscript has already been published and two more are in preparation.

#### NATO Consultant

Prof. Michael Peterson, University of Maine, Orono, United States

#### Other Collaborating Institutions

- Menahem Priel, Mekorot Water Company, Tel Aviv, Israel
- Ratib Al Adwan, Water Authority of Jordan, Amman, Jordan

#### Intellectual Property (IP) Rights

An IP/license agreement between CU and ROTEC (company set up for commercialization in which both BGU and Mekorot are partners) has enabled preparation and filing (July 2010) of a provisional patent application based on the proof-of-concept results achieved for ultrasonic sensor control of flow reversal during RO operation. Completion of full patent filing is anticipated by July 2011.

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Abbreviations: BGU: Ben Gurion University; CU: University of Colorado; HU: Hashemite University; MWC: Mekorot Water Company; NSF: National Science Foundation; RO: Reverse osmosis; TF: Tapered flow; WAJ: Water Authority of Jordan



SfP 982614

## Assessment and Development of Alternative Water Resources in the Sinai Peninsula, Egypt

Project Co-Directors: Mohamed Sultan, Western Michigan University, Kalamazoo, U.S.A. (NPD)  
Farouk Soliman, Suez Canal University, Ismailia, Egypt (PPD)  
Mohamed Rached, Suez Canal University, Ismailia, Egypt  
Mohamed Mohmoud, Ministry of Water Resources and Irrigation, Giza, Egypt

Approval Date: 1 June 2007  
Effective Starting Date: 1 July 2007  
Duration: 4 years, until October 2012  
NATO Budget: EUR 205,000

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Information about the SfP Project through Internet: [www.esrs.wmich.edu](http://www.esrs.wmich.edu)

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### Abstract of Research

A five-fold exercise is being conducted to assess the groundwater potentiality in the Sinai Peninsula. First, a field campaign is being conducted to sample and analyze groundwater and surface water samples from the investigated area for geochemical, isotopic (e.g. O and H stable isotope compositions), geochronologic analysis (e.g.  $^{14}\text{C}$  and  $^{36}\text{Cl}$ ). Second, a database is being generated to host all relevant data sets including published data in a GIS environment for a better understanding of the spatial relationships between these data sets. Co-registered digital mosaics are being generated from relevant data sets including remote sensing (e.g. Landsat TM, SIR-C, SRTM, TRMM), geochemical (solute concentrations, O and H stable isotope composition), geological (geologic maps) and hydrological (e.g. lithology, depth to water table) data sets. Third, a web-based GIS interface (ArcIMS) is being developed to provide a vehicle for data analysis, visualization, and dissemination. Fourthly, using the developed web-based GIS and geophysical methods, locations for potential productive wells targeting different types of shallow (<200m) reservoirs will be identified. The validity of the methodology will be tested against existing wells in the Sinai Peninsula. Final selection of drilling locations will be dictated by technical (geophysical), financial (cost of drilling) and social aspects responding to needs expressed by local communities/authorities. Results will be shared with the Ministry of Water Resources & Irrigation (MWRI), our partner on the UNDP-GEF project. Fourthly, calibrated rainfall-runoff models and groundwater flow models will be developed to simulate runoff, recharge, and to compute sustainable extraction. Fifthly, throughout the duration of the project, the national researchers will receive locally and in the US training on various aspects of the adopted integrated applications and approaches. Specifically, training will be conducted of GIS, remote sensing, geochemistry, and geophysics in groundwater exploration.

### Major Objectives

- Develop in-country scientific and technical capabilities in the area of assessment of alternative water resources. This will be attained by conducting training for the participants, acquisition of laboratory (hardware, software) for image processing, and hydrologic modeling. Also, by presenting findings in national and international meetings by the involved national scientists, especially the junior scientists.
- Collect and conduct geochemical and isotopic analyses on water samples from existing wells and water bodies.
- Identify the origin of subsurface waters in all of the main valleys of the Sinai Peninsula by analysis of geochemical and isotopic data.
- Develop a web-based GIS to host all relevant data sets (our data and published data).
- Identify the watersheds and stream network in the study area.
- Collect all available satellite-based precipitation data for the study area.
- Generate, test, refine, and validate an integrated continuous rainfall-runoff model for mountainous arid regions that combines temporal and spatial distribution of rainfall with appropriate infiltration parameters for various soil types to estimate infiltration. Test and refine the model at several locations by using data on flooding events.
- Produce a map that highlights potential well locations.
- Test the validity of the selected sites by geophysical methods and drilling.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Compiled a collection of published data that will be part of our digital data base (95%).
- Collected and analyzed groundwater samples for chemistry and isotopic systematics (75%).
- Collected digital products and digitized maps (85%).
- Digital mosaics covering the study area were generated from individual units (Landsat scenes) (85%).
- We generated a digital elevation map for the study area from SRTM data that was used to delineate watersheds across Sinai (100%).
- We processed 3-hourly TRMM precipitation data over Sinai from 1998 to 2007, which represents 80% of the available TRMM data (1998-2007) (95%).
- We generated a preliminary web-based GIS database and integrated the IMS within a Google API framework to host and distribute the data (95%).
- We presented our findings (6 presentations) in the meetings of the Geochemical Society of America.
- We hosted three Egyptian scientists and trained them on Remote Sensing & GIS principles.
- We conducted several geophysics investigations in Wadi Zalaga and Baraga.
- We constructed a rainfall-runoff model for the Sinai Peninsula using field and remote sensing datasets.
- We installed soil temperature probes in several wadis and obtained infiltration rates.
- Using an integrated approach (geophysics, geochemistry, remote sensing) we showed that the fossil Nubian Aquifer water is receiving modern recharge and hence could be used in a sustainable manner if the average amounts of modern recharge could be assessed.
- We computed the sustainable amounts of water representing the modern recharge for the Nubian Aquifer using continuous rainfall runoff models.
- We conducted geophysical investigation to validate inferences from our methodologies for groundwater exploration.

Payments through NATO Funds: EUR 171,179

### Milestones for the Next Six Months

- Continue all the tasks that we started.
- Process the newly acquired geophysical data during September of 2011.
- Interpret/analyze the newly acquired geophysical field data in conjunction with other available datasets.
- Continue generating digital products and processing of TRMM data.
- Continue to enhance and add data to the web-based GIS.
- Evaluate groundwater infiltration/recharge rates from preliminary results of soil temperature probes collected on the recent field excursion.
- Write a manuscript to be published as a chapter in a book that summarizes our research on the Nubian aquifer in Sinai, other parts of Egypt (e.g. Eastern and Western Deserts) and in neighboring countries.
- Write an article of the origin of the Nubian groundwater using noble gas, <sup>14</sup>C age dating, O and H isotopic compositions of samples we collected.
- Present results in national and international meetings.

### Implementation of Results

We have established a web-based GIS to facilitate the transfer of project results to the end-users. The web-based allows users to view, interact, and download all of the current datasets produced for the project thus far. Discussions are underway to bring NARSS (National Authority for Remote Sensing and Space Sciences) as a new end user for the developed methodologies.

NATO Consultant : N/A

### Other Collaborating Institutions

- Desert Research Institute in Cairo, Egypt

Dr Saffei Elden Mohamed Metwally is a geophysicist who has extensive experience in Sinai. He has spent six months (Oct.07-Mar.08) at Western Michigan University working with us on the project. He provided approximately 150 VES that he collected from various wadis in Sinai that are now on our web-based GIS.

Intellectual Property (IP) Rights : N/A

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Abbreviations: UNDP: United Nations Development Programme; GEF: Global Environmental Facility; GIS: Global Information System; SRTM: Shuttle Radar Topography Mission; TRMM: Tropical Rainfall Measurement Mission; SIR-C: Shuttle Imaging Radar-C; Landsat TM: Landsat Thematic Mapper; MWRI: Egyptian Ministry of Water Resources & Irrigation; ArcIMS: Arc Internet Mapping Service; DEMs: Digital elevation models

SfP 982678

## **Bio-Optical Characterization of the Black Sea for Remote Sensing Applications**

Project Co-Directors: Prof. Temel Oguz, IMS, Erdemli, Turkey (NPD)  
Dr. Atanas Palazov, IO, Varna, Bulgaria (PPD)  
Dr. Michael Lee, MHI, Sevastopol, Ukraine  
Dr. Oleg Kopelevich, SIO, Moscow, Russia  
Dr. Viorel Malciu, NIMRD, Constanta, Romania

Approval Date: 12 December 2008  
Effective Starting Date: 10 November 2009  
Duration: 3 years, until 10 November 2012  
NATO Budget: EUR 183,500

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Information about the SfP Project through Internet: [www.natosps.io-bas.bg](http://www.natosps.io-bas.bg)

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### Abstract of Research

The project, within the framework of the environmental security research topic, aims at the implementation of a tool to support remote sensing applications for the operational environmental monitoring and climate studies in the Black Sea. This final objective is expected to be achieved through the implementation of new models and algorithms in a processing chain for ocean colour imagery. The new models and algorithms for the quantification of the concentration of seawater optically significant constituents (mostly chlorophyll a, total suspended matter and yellow substance), will result from the analysis and application of comprehensive in situ bio-optical measurements of optical properties (inherent and apparent) and concentration of seawater optically significant constituents performed during two major oceanographic campaigns.

### Major Objectives

- To create an in situ data set of optical properties (inherent and apparent) and concentration of seawater optically significant constituents for the Black Sea.
- To develop a new bio-optical algorithm for the determination of optically significant seawater constituents for Black Sea environmental monitoring through Earth observing systems (mostly the Medium Resolution Imaging Spectrometer (MODIS) onboard the NASA AQUA polar platform).
- To validate a new regional bio-optical algorithm.
- To cross-compare of regional and global bio-optical algorithms.
- To generate satellite ocean-colour products of the Black Sea freely accessible through web interface.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Organisation of the first kick-off meeting in November 2009, in Istanbul, Turkey.
- Purchase request/ delivery of the free-fall profiler.
- Assessment of measurement method was carried out through the cross-site comparison of early bio-optical data collected by the JRC scientific team in the Black Sea in 2006 and 2009.
- Joint research proposal was submitted to obtain funding for ship-time through the EUROFLEETS program. The project was granted in the late Fall 2010.
- Three consecutive bio-optical oceanographic cruises were carried out in the Western and Central Black Sea (01-23.07.2011) with EUROFLEETS BIO-OPT Project and Contract # 386675 between JRC of EC and Institute of Oceanology, BAS to support the activities of the NATO SfP 982678 Project.
- 112 bio-optical measurements were carried out in the Western and Central Black Sea waters during the cruises.
- Training on Optical Profile Measurements and Data handling was carried out onboard Mare Nigrum and Akademik.
- A new spectral transparency meter was made, for future use in calibration of Volume Scattering Function meter during the both planning bio-optical expeditions.
- Presentation of the results of preliminary analysis of data obtained in the Black Sea was made at three International Conferences.

- Project Internet web site was prepared and is now available under Institute of Oceanology, BAS web server: [www.natosps.io-bas.bg](http://www.natosps.io-bas.bg).

Payments through NATO Funds: EUR 108,621

#### Milestones for the Next Six Months

- Analysis and assurance of data from first cruise.
- Project Annual review meeting will be held at Istanbul, Turkey in November 2011.
- Development of bio-optical algorithms.
- Training on Optical Profile Data Analysis and Applications.

#### Implementation of Results

The Institute for Environment and Sustainability of the Joint Research Centre is a major civil entity that will make use of the outcomes of the scientific activities of this project in its processing chain for satellite ocean colour data in view of generating more accurate remote sensing products for the Black Sea.

#### Other Collaborating Institutions

- Maritime Hydrographic Directorate, Romania
- Research Center of the Navy, Romania

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Abbreviations: IMS- Institute of Marine Science; IO- Institute of Oceanology; MHI- Marine Hydrophysical Institute; SIO- Shirhov Institute of Oceanology; NMRD- National Institute for Marine Research and Development; JRC- Joint Research Centre; NASA- National Aeronautics and Space Administration; ROSA- Romanian Space Agency; ESA- European Space Agency

SfP 982816

## **Environmental Security Enhancement through and Innovative Process for Nitrogen Removal**

Project Co-Directors: Prof. Gerasimos Lyberatos, FORTH/ICEHT, Greece (NPD)  
Dr. Julian Shehu, AGT, Albania (PPD)  
Dr. Michael Kornaros, UPATRAS, Greece (Co-NPD).  
Prof. Gamal Abou El-Magd, El-Minia, Egypt

Approval Date: 12 July 2006  
Effective Starting Date: 1 October 2006  
Duration: 3 years, until September 2011  
NATO Budget: EUR 290,000

### Abstract of Research

The environmental conditions of selected water receptors in Albania and Egypt will be monitored year-round. Two pilot plants achieving nitrogen removal (SBR type) through nitrate by-pass (PND process) will be built in selected sites in the two countries. Young researchers will be trained in analysis of wastewater and in operation of pilot plants. A mathematical model will be developed for the process and used for optimization. The performance of the pilot plants will be assessed. A technoeconomic study will assess the viability of this technology in the two countries. The results will be disseminated through internet, brochures and conferences.

### Major Objectives

- Central laboratory training of reference laboratories on microbiological ISO standards for drinking water  
To assess the current environmental conditions of selected stressed water receptors in Albania and in Egypt.
- To assess annual variation of wastewater quality characteristics at selected sites.
- Select sites for installation of pilot scale SBR plants (one in Albania and one in Egypt).
- To design and commission an SBR pilot plant installed at selected site in Albania.
- To design and commission an SBR pilot plant installed at selected site in Egypt.
- To train two Albanian and two Egyptian young researchers.
- To obtain kinetic data from the operation of SBR pilot plants in Albania and Egypt.
- To assess the performance of pilot plants at the optimum operating conditions.
- To develop a mathematical model calibrated using kinetic data from the operation of SBR pilot plants in Albania and Egypt.
- To develop optimal operating strategies for SBR operation based on PND-process and the particular wastewater characteristics in Albania and Egypt.
- To carry out a technoeconomic analysis of the proposed PND-process for cost-effective treatment of municipal wastewater in Albania and Egypt.
- To disseminate the project results through a public internet homepage presenting the project and the public part of project results and through brochures describing the process and its advantages in the Albanian and the Egyptian language as well as in English.

### Overview of Achievements since the Start of the Project until 30 April 2011

In Albania, sites for monitoring were selected and all sampling campaigns (four) were made. Analytical equipment was purchased. The samples were analyzed. The pilot plant was installed and started operating. In Egypt data were collected for the influent in three wastewater treatment plants, the site for the pilot plant was selected and the pilot plant has been ordered. In Greece, the Egyptian pilot plant specifications were determined, the pilot plant was constructed, a mathematical process model was developed and young scientists from Albania and Egypt were trained. One publication and two conference presentations have resulted from this project so far.

Payments through NATO Funds: EUR 230,421

## Milestones for the Next Six Months

### **Albania**

- Operation and optimization of pilot scale SBR.
- Dissemination activities of the project.

### **Egypt**

- Commissioning of SBR Pilot Plant at El-Minia University.
- Experimental design and start up of the system.
- Full operation of the system and collection of the data.
- Further training of the young researcher on the controlling strategy of the system and evaluation of the experimental data.
- Dissemination activities of the project.

### **Greece**

- In the next six months the Greek partners will assist the Albanian and Egyptian partners in properly operating the pilot plants and will further train Egyptian students.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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Abbreviations: NPD: Project Director from NATO country (Greece); PPD: Project Director from country-partner (Albania); SFP: Science for Peace; SBR: Sequencing Batch Reactor; AGT: Agricultural University of Tirana; EMU: El\_Minia University; BOD: Biochemical Oxygen Demand; COD: Chemical Oxygen Demand; EU: European Union; UPATRAS : University of Patras, Department of Chemical Engineering; FORTH/ICEHT : Foundation of Research and Technology/ Institute of Chemical Engineering and High Temperature Chemical Processes

SfP 983134

## Investigating salinity and radioactivity in water resources in Morocco

Project Co-Directors: Avner Vengosh, Duke University, Durham, NC USA (NPD)  
Lhoussaine Bouchaou, Ibn Zohr University, Agadir, Morocco (PPD)  
Bendaoud Bouguenouch, ABHSM, Agadir, Morocco (co-PPD)  
M'hamed El Fasskaoui, ABHSM, Agadir, Morocco (co-PPD)

Approval Date: 15 July 2008  
Effective Starting Date: 15 October 2008  
Duration: 4 years, until October 2012  
NATO Budget: EUR 234,000

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Information about the SfP Project through Internet: <http://duke.edu/web/sfpmorocco/Home.html>

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### Abstract of Research

Morocco is one of the most arid regions of the world and based on many IPCC climate models annual rainfall is expected to decrease over the next few decades. With increasing demands for drinking water and irrigation (90% of water in Morocco is used for agriculture) the water crisis in Morocco is expected to become exaggerated. The increase in groundwater exploitation is also associated with a rapid increase of the salinity in many of the aquifer systems of Morocco. The high salinity of groundwater has become a limiting factor for sustainable management of the water resources, and therefore has important implications for future economic development and social and political stability in Morocco. Water authorities are already struggling to distribute and provide potable water to the domestic and agricultural sectors.

This NATO project aims to investigate the groundwater quality (with a focus on the effects of salinity and radioactivity) of four major basins in Morocco (Souss-Massa, Draa, Ziz, and Tadla) through a collaborative effort between Duke University and University of Ibn Zohr in Agadir. This study aims to provide a systematic analysis of geochemical and isotopic compositions of saline groundwaters from the selected aquifers, which will help to evaluate the sources of salinity, mechanisms for salinization, as well as the first investigation of naturally occurring radioactive nuclides in water resources in Morocco. Identifying the origin of salinity and radioactivity is crucial for water management, model prediction, and remediation. This analysis will help to establish a scientifically-based water management plan with specific recommendations for the end-users for sustainable exploitation of the water sources in the investigated basins.

### Major Objectives

- Monitor the overall salinity distribution in water resources by generating a reliable database,
- Establish a comprehensive and operational database of dissolved constituents and trace metals in groundwater and install a Geographical Information System,
- Establish analytical facilities in Ibn Zohr University for major chemistry and radium-226,
- Evaluate the sources and mechanisms of groundwater salinization; establish geochemical tools for discrimination of naturally occurring salinity from anthropogenic sources,
- Establish hydrogeological models for evaluating groundwater recharge, flows and salinization process in the different aquifer systems,
- Assess the levels of naturally occurring radium isotopes ( $^{226}\text{Ra}$ ,  $^{228}\text{Ra}$ ,  $^{224}\text{Ra}$ ,  $^{223}\text{Ra}$ ) and uranium and possible threats to the local communities who use the groundwater,
- Define the relationships between salinity, water hydrochemistry, aquifer lithology, and levels of radioactivity in an attempt to establish a prediction tool for radioactivity in water resources,
- Investigate the potential alternative water resources for substituting existing groundwater resources in the Souss-Massa basin; evaluate the suitability of saline groundwater as a source for reverse osmosis desalination; and assess the suitability and sustainability of using fossil and geothermal waters as alternative water sources,
- Work with end-users from the Souss-Massa basin for implementation and establishing alternative water management practices including remediation of the water quality in the basin and continuation of exploitation under salinization conditions,
- Establish a scientifically-based water management model for sustainable exploration of water resources

in the Souss-Massa basin; investigate the applicability of this model given the socio-economic and political constraints.

#### Overview of Achievements since the Start of the Project until 30 April 2011

- Training of PPD team on operation of RAD-7 radium measurement device completed December 2008.
- Purchase and installation of RAD-7 radon detector for use by PPD team.
- Field sampling of Tadla, Draa, Ziz and Souss-Massa Basins: December 2008, May 2009, January 2010, April 2010, May 2010, and June 2010; collected two hundred seventy five (275!) samples from the Draa (102 samples), Ziz (57), Souss-Massa (74) and Tadla (42) basins.
- Continue of analytical measurements and data evaluation from January 2009 through the present (October 2011).
- Presentations of findings at several conferences: Geological Society of America (GSA), American Geophysical Union (AGU), Goldschmidt, Integrated Water Resources Management and Challenges of the Sustainable Development (GIRE3D), International Atomic Energy Association (IAEA), International Symposium on Isotopes in Hydrology, Marine Ecosystems and Climate Change Studies, 21<sup>st</sup> Salt Water Intrusion Meeting and Applied Isotope Geochemistry (AIG-9) meeting.
- Training of PPD team members Tarik Tagma and Zineb Lgourna on the use of laboratory equipment and methods at Duke University November-December 2009.
- Purchase of stable-isotope analyzer, calibration at Duke University and installation at Ibn Zohr University in Agadir.
- Conducted a workshop in Agadir (June 25, 2011) for presentation of the results generated in the study, that included the NPD and PPD project teams, Projec PPD Co-Directors and project End-users.

Payments through NATO Funds: EUR 179,524

#### Milestones for the Next Six Months

During the next six months (November 2011-April 2012) the NPD and PPD project teams plan the following activities:

- Complete measurements of the remaining chemical isotopes and radioactivity (including Ra-226 and Ra-228) from the samples collected in the project.
- Interpret the data from the collected samples. Complete the preparation of the scientific report on the mechanism of salinization in the Draa Basin.
- Complete the installation of the mobile stable isotope analyzer for the measurements of oxygen and hydrogen isotopes at the LAGAGE laboratory in Ibn Zohr University in Agadir and train the team members on its applications.
- Prepare for the project workshop and presentation to the water authorities in Morocco (planned for spring 2012).

#### Implementation of Results

A meeting with the end-users took place in March 2010 in which the initial results of sampling were distributed. These results (including maps of salinity and radioactivity) were used to facilitate discussions on future field sampling missions and focus the analysis efforts. End-users from the National Office of Drinking Water (ONEP) Agadir and the Regional Office of the Agricultural Development of Souss-Massa (ORMVASM), attended this meeting. The different stakeholders will be invited to the workshop planned for spring 2012 to participate in data evaluation and assimilation.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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Abbreviations: ABHSM: Hydraulic Agency of Souss-Massa Basin ; ONEP: National Office of Drinking Water ; ORMVASM: Office of the Agricultural Development of Souss-Massa ; NPD: NATO Country Project Director ; PPD: Partner Country Project Director

SfP 983945

## Assessing transboundary water pollution in Central Asia

Project Co-Directors: Prof. Eiliv Steinnes, Trondheim, Norway (NPD)  
Prof. Oktiabrin Sadyrov, Bishkek, Kyrgyzstan (PPD)  
Prof. Zafar Razykov, Hudjand, Tajikistan  
Prof. Nasrulla Ismailov, Tashkent, Uzbekistan  
Prof. Uylesbek Besterekov, Shymkent, Kazakhstan

Approval Date: 23 May 2011  
Effective Starting Date: 1 July 2011  
Duration: 3 years, until July 2014  
NATO Budget: EUR 569,000

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Information about the SfP Project through Internet: *to be created*

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### Abstract of Research

Due to initial delay the effective starting date of the project is fixed at July 1, 2011. The main equipment to be used in the project has been decided, and installation is expected in the near future. Efforts to renovate the laboratory areas designated for the project are under way in the four participating universities. No research can be performed before the equipment is in place and the personnel working in the project has received the necessary training. The basic training session is scheduled at January 2012.

### Major Objectives

- To follow the concentration of nine key heavy metals in the Syr-Darya river systems over a period of three years in order to assess variations in contamination levels and the extent of transboundary transport of these metals between the Central Asian countries of Kyrgyzstan, Kazakhstan, Tajikistan and Uzbekistan.
- To lay the foundation for a permanent joint water monitoring program in the region, involving these four countries, who all depend on Syr-Darya as a main water resource.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Decision has been made on the purchase of equipment for Atomic Absorption Spectrometry (AAS), the main instrumental tool to be used in the project.
- The AAS equipment has been ordered, and delivery to the four universities and installation is underway.
- Equipment for the purification of water, which is a must for the trace element analyses to be performed, has been ordered and will be delivered in due course.
- The first official Project meeting was organized in Bishkek on September 5-8, 2011.
- Renovation of the laboratory facilities to be used in the project is completed in Kyrgyzstan and underway in the other Partner Countries.
- An agreement has been reached with the Alex Stuart Laboratories, Karabalta, Kyrgyzstan on the conditions for training of personnel from the four universities in AAS Spectrometry.

Payments through NATO Funds: EUR 76,550

### Milestones for the Next Six Months

- Final installation of AAS equipment (December 1, 2011)
- Preparation of Quality Assurance Project Plan (March 1, 2012)
- Training of laboratory staff (March 15, 2012)
- Acquisition of equipment for field registrations (February 1, 2012)
- Development of field schedules (February 15, 2012)
- Start field sampling (March 1, 2012)

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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Abbreviations: AAS: Atomic Absorption Spectrometer; CPO: Common Procedures of Operation; GLP: Good Laboratory Practice; FCCT: Faculty of Chemistry and Chemical Technologies; ICP: Inductively Coupled Plasma spectrometer; KNU: Kyrgyz National University; KR: Kyrgyz Republic; MiTA: Micro-Trace Analysis; MMIT: Mining-metallurgical Institute of Tajikistan; MSU: Moscow State University; NPD: NATO Country Project Director; NTNU: Norwegian University of Science and Technology; PPD: Partner Country Project Director; QA: Quality Assurance; QAPrP: Quality Assurance Project Plan; QC: Quality Control; RK: Republic of Kazakhstan; SAEL: Stewart Assay and Environmental Laboratories; SKSU: Southern Kazakhstan State University; TCTI: Tashkent Chemical-Technological Institute; TR: Tajik Republic; UDS: Unified Database System; UzR: Uzbek Republic

SfP 984073

## **Development of a Decision Support System for Reducing Risk from Environmental Pollution in the Bosna River**

Project Co-Directors: Dr. Jarmila Makovinska, Water Research Institute, Bratislava, Slovakia (NPD)  
Dr. Tarik Kupusovic, Hydro-Engineering Institute, Sarajevo, Bosnia & Herzegovina (PPD)  
Branko Vučijak, Hydro-Engineering Institute, Sarajevo, Bosnia & Herzegovina  
Selma Čengić, Hydro-Engineering Institute, Sarajevo, Bosnia & Herzegovina  
Dalila Jabučar, Hydro-Engineering Institute, Sarajevo, Bosnia & Herzegovina  
Branislav Vrana, Water research Institute, Bratislava, Slovak Republic

Approval Date: 31 December 2010  
Effective Starting Date: 17 May 2011  
Duration: 3 years, until May 2014  
NATO Budget: EUR 270,000

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Information about the SfP Project through Internet: <http://www.heis.com.ba/projekat/>

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### Abstract of Research

A Decision Support System (DSS) addressing the environmental pollution by the EU WFD Priority Substances (11 out of total 41 pollutants; Directive 2008/EC/105) has recently been developed within the European Union 6th Framework Programme (FP6) project SOCOPSE. Its implementation in all EU Member States is strongly promoted by the European Commission. A unique approach for the prioritisation of the Bosna River Basin specific substances will be applied. After a thorough screening of all point and diffuse sources of pollution in the basin using the state-of-the-art analytical techniques, the toxicity of individual identified compounds will be determined by the novel QSAR (Quantitative Structure Activity Relationship) computer modelling technique. The DSS was tested in six case studies in the EU, BiH will be the first country outside of the EU to use it.

### Major Objectives

The main objective of the proposed project is to develop a DSS allowing identification of major risks related to environmental pollution in the Bosna river basin and propose technical solution for the reduction/removal of the pollution. The following specific objectives need to be achieved in order to fulfil the main objectives:

- Establishment of a "pollution baseline" in the Bosna River basin based on newly obtained chemical, biological, hydromorphological and microbiological data.
- Identification of major polluters via systematic screening of urban and industrial waste water streams.
- Prioritisation (risk assessment) of the most relevant "Bosna River Basin specific substances" and establishment of the Emission Limit Values for major polluters.
- Proposal of technical installations to be used for reduction of pollution together with economic analysis.
- Development of investment scenarios for the decision makers.
- Improvement of the scientific collaboration between the participating countries (Slovak Republic and BiH) and entities (RS and FBiH).
- Serving as an example project for all sub-basins within Bosnia and Herzegovina and also the entire Western Balkans area.

### Overview of Achievements since the 17 May 2011 until 30 September 2011

Project works were focused mainly on successful start of the project, preparation of bases for communication in project team, with end users of the project results, stakeholders in the river basin. During this starting period the following tasks were realised:

- Preparation and realization of kick-off meeting.
- Creation and opening of the project Web page, design of the first issue of the project newsletter.
- Acquaint with the equipment and needs of HEIS laboratories, technical assistance for preparation of technical specification for procurement of sampling and laboratory equipment for HEIS.
- Preparation and realization of sampling trainings for colleagues from HEIS, Sarajevo at the Water

Research Institute in Bratislava held on 6-9 September 2011.

- Active involvement of young scientists into the project works-preparation of overview of Bosna River Basin, preparation of sampling programs, passing of courses of sampling.
- Collection of available data on Bosna river basin and polluters, technical assistance in identification of Bosna river surface water monitoring sites and significant pollution sources.

The works in the starting period focused on achievement of the objectives 1 and 2. In the reported period data on Bosna River water quality available from different sources have been collected, organized and reviewed. Overview and preliminary list of significant polluters in Bosna river basin has been prepared. This database served as baseline to understand in detail the problematic and draft a plan for sampling campaign. 16 sampling sites of surface water have been selected and 11 points of source pollution discharges have been identified as priority for monitoring. Other activities successfully accomplished regard training on automatic sampling and passive sampling techniques where two staff members of HEIS participated in a training course organized by WRI in Bratislava. The Web page has been established. A Newsletter has been designed and ready to be distributed.

Payments through NATO Funds: EUR 5371,40

#### Milestones for the Next Six Months

During the next six month period it is planned the purchase of necessary sampling and laboratory equipment and the realization of the main sampling campaign. Main results are the assessment of the Bosna River status and determination of Bosna River Basin specific pollutants. In parallel a review of possible sources of pollution and a sampling campaign will be performed. Personnel will be trained on sampling and laboratory techniques and harmonized sampling procedure will be agreed. In the end it is foreseen a workshop for (local) industrial stakeholders. Milestones for the following 6 month period are: a) list of Bosna River pollutants and b) local stakeholders informed.

#### Implementation of Results

At this early stage of project, implementation end-users (Watershed Agencies) have been involved in the first phase activities. Project has cooperated with them in form of providing existing data (available in their databases) and commenting selected locations for sampling campaign. Project Website has been established and first Newsletter distributed.

NATO Consultant : Dr. Ales Bizjak

#### Other Collaborating Institutions :

- Natural Resources Department, State Ministry of Trade and Economic Relations, Sarajevo, Bosnia & Herzegovina
- Watershed Agency for the Sava River Basin, Sarajevo, Bosnia and Herzegovina
- Watershed Agency for the Sava River Basin, Bijeljina, Bosnia and Herzegovina

Intellectual Property (IP) Rights : N/A

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Abbreviations: WRI-Water Research Institute; HEIS-Hydro-Engineering Institute Sarajevo

SfP 984087

## **Drinking water quality risk assessment and prevention in Novi Sad municipality, Serbia**

Project Co-Directors: Assoc. Prof. Ing. Ivan Špánik, Faculty of Chemical and Food Technology, Institute of Analytical Chemistry, Bratislava, Slovak Republic (NPD)  
Prof. emeritus Mirjana Vojinovic Miloradov, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia (PPD)

Approval Date: 31 December 2010  
Effective Starting Date: 2 June 2011  
Duration: 3 years, until May 2014  
NATO Budget: EUR 270,000

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Information about the SfP Project through Internet: *will be established by the end of November 2011*

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### Abstract of Research

The available information concerning the risk assessments and risk management standards for the protection of drinking water resources in Novi Sad is insufficient. Within the last 5 years, no detailed and no systematic monitoring programme for the screening of river pollutants and emerging substances in Novi Sad municipality was performed. However, monitoring of selected target substances was a subject of several domestic research projects. In the first phase of the Project, the detailed screening of surface water and groundwater wells situated at three locations in the aquifer of alluvium along the Danube River used for abstraction of drinking water will be performed. The monitoring of waste water (municipal and industrial from Novi Sad area) discharged into the Danube will be performed. The identified contaminants will undergo further study to determinate their toxicity using QSAR software modeling. The approximate PNEC-values will be determined for all substances frequently occurring in the water samples. The information on organic and inorganic pollutants and their toxicity data gained during the Project will be used in the construction of a fully automated early warning system which will allow simultaneous unattended and reliable monitoring of the most frequently detected hazardous pollutants in the water of Danube in vicinity of Novi Sad. The installed early warning system in Public Utility Company will allow effective water quality management and fast risk assessment which meets domestic health and security needs for the protection of population and environment in Vojvodina, Serbia and broader. Gained results within the Project will be disseminated to other cities of Vojvodina and Serbia.

### Major Objectives

- The main goal of the proposed project is to reduce and prevent risks related to environmental quality of surface water and related aquifers used for abstraction of drinking water.
- Gain more insight into organic and inorganic contaminants present in the raw water used for drinking water production at Novi Sad and evaluate their risks for human health and the environment.
- Establishment and operation of a fully automated early warning system at the PUCNS.
- Development of a database for storage of monitoring data, fully compatible with standard European data collection systems such as NORMAN.
- Improvement, integration and harmonization of risk assessments and risk management standards for the protection of drinking water resources.
- Implementation of joint risk management plans and strategies against hazards, which might be caused by the chemical substances in source water.
- Serve as an example for other cities with similar drinking water production.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Kick off meeting was organized in Novi Sad, on June 2<sup>nd</sup> and 3<sup>rd</sup>, 2011.
- Overview of already monitored organic and inorganic substances within domestic institutions (Jaroslav Černi Institute, Institute of Public Health of Vojvodina, Department of Chemistry, Biochemistry and Environmental Protection Faculty of Sciences\_UNs, Public Utility Company and research projects).
- Overview of already monitored organic and inorganic substances within international projects (Joint

- The list of detected organic and inorganic substances with concentrations higher than the Limit of Quantification.
- The selection of sampling sites for further screening analysis.
- Taking samples from two selected sampling sites.
- Development of sample treatment methods for screening analyses.
- Preliminary GC-MS screening analyses of wastewater entering Danube above abstraction point.
- Preliminary determination of selected target compounds (PCB, PAH, OCP, anions etc.) of wastewaters entering Danube above abstraction point.
- Preliminary selection of laboratories to perform screening and target analyses.
- Published four full papers in Proceedings in Congress in Romania, Slovakia, Hungary and Serbia (Novi Sad, Zrenjanin).
- Published 9 articles in 5 different journals, Serbian newspaper and magazines. Professor Mirjana Vojinovic Miloradov had two interviews on Serbian TV shows presenting project DriWaQ-NS supported by NATO SfP. Edited video material from the Kick Off Meeting in Novi Sad was prepared by the Radio Television of Vojvodina. Five short information from the Kick Off Meeting in Novi Sad were presented on four different radio and TV stations in Serbia. Information about the project and the Kick Off Meeting has been presented on the web sites of the Faculty of technical Sciences and the Department of Environmental Engineering in Novi Sad.

Payments through NATO Funds: EUR 7,500

(As agreed, the project is using remaining balance on planning grant which will be reported separately by the end of the November 2011)

#### Milestones for the Next Six Months

- Training courses for personnel in UNS and PUCNS focused on sampling, sample treatment and development of analytical methods.
- Development of sample treatment and analytical methods for screening and target analyses.
- Analysis of water samples.
- Overview of the detected compounds.

#### Implementation of Results

*Not applicable at this stage*

NATO Consultant : Dr. Jaroslav Slobodnik, Environmental Institute, Kos, Slovakia

#### Other Collaborating Institutions :

Public Utility Company Waterworks and Sewerage, Novi Sad, Serbia.

Intellectual Property (IP) Rights : *Not applicable*

Abbreviations: EWS: Early Warning System, GC-MS: Gas Chromatography with Mass Spectrometry, NORMAN: Network of Reference Laboratories for Monitoring of Emerging Environmental Pollutants, OCP: Organochlorine Pesticides, PAH: Polyaromatic Hydrocarbons, PCB: Polychlorinated Biphenyls. PNEC: Predicted No Effect Concentration, PUCNS: Public Utility Company Waterworks and Sewerage Novi Sad, QSAR: Quantitative Structure Activity Relationship, UNS: University of Novi Sad

SfP 983368

## **Assessment and Monitoring of Desertification in Jordan using Remote Sensing and Bioindicators**

Project Co-Directors: William Nickling, GU, Guelph, Canada (NPD)  
Jawad Al-Bakri, UOJ, Amman, Jordan (PPD)  
Hani Saoub, UOJ, Amman, Jordan  
Mohammad Salahat, HU, Zarqa, Jordan  
Saeb Khresat, JUST, Irbed, Jordan

Approval Date: 3 December 2008  
Effective Starting Date: 28 March 2009  
Duration: 3 years, until March 2012  
NATO Budget: EUR 251,500

### Abstract of Research

This project contributes to Jordan's efforts to combat desertification and to assess the existing agricultural resources in terms of degradation. The project aims to implement the contemporary tools of remote sensing and GIS modeling to identify and select bioindicators for assessment and monitoring of desertification. Work on the project commenced in March 2009 and with completion expected by the end of 2012. During the last 18 months, several milestones and deliverables were achieved. The activities of the project were primarily focused on: 1) instrumentation, 2) capacity building and training, 3) collection and analysis of data and 4) modeling of grought and soil erosion by wind. The main outputs were the processing analysis of remote sensing and ground data, mapping and study of existing and historical land use in the study area (Yarmouk basin), mapping and spatial distribution of drought with EWSI, preparation of data and testing of the wind erosion model. Correlating remote sensing data and radiometer measurements sith soil salinity was achieved, while correlation with other soil data is in the process. Training was carried out for end users, young researchers and co-directors in Canada and in Jordan. The different training sessions empowered the skills of the Jordanian team who, in turn, was able to carry out the part of soil erosion model and the analysis of RADARSAT II images and soil moisture data. Future training sessions will be carried out in Jordan and in Canada to transfer the gained knowledge to end users and young researchers. The generated maps and the developed models will be used and incorporated to produce the final maps on desertification status and risk in the study area.

### Major Objectives

- Selection of appropriate indicators of soils, vegetation and remote sensing data that are indicative of desertification.
- Assess of the potential of wind and water erosion in the study area as important indicators of desertification.
- Transfer the resulting integrated approach of desertification assessment to end users, decision and policy makers.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Purchase of instruments and equipments for GIS lab and other soil labs at UOJ and HU.
- Collection and analysis of ground data and spectral reflectance measurements.
- Mapping of existing and historical land use/cover of the study area.
- Processing and analysis of remote sensing data including MODIS, ASTER and RADARSAT II.
- Training of end users, co-directors and young researchers at the University of Guelph in Canada and at the University of Jordan in Amman.
- Kick-off meeting in October 2009 in Amman with participation of end users.
- Drought mapping with EWSI.
- Application of wind erosion model (DUST\_EM) and generation of wind erosion maps.
- Identification of remote sensing bands that can be used for mapping desertification.
- Correlating RADARSAT II against soil moisture and mapping soil moisture content using empirical and semi-empirical models.

### Milestones for the Next Six Months

- Finishing the part of soil erosion models.
- Purchase and installation of remaining instruments.
- Identification of remote sensing indicators for monitoring desertification.
- Scientific publications.

### Implementation of Results

The end users will continue to be involved in all main activities of the project and will be trained on the different aspects of modeling and assessment of desertification. All results will be transferred to end users who will be involved in implementing the country's strategy and action plan to combat desertification. In addition to the end users, the project was presented to the National Committee to Combat Desertification, who suggested the development of a proposal for the MoEnv to establish a desertification information system (DIS). So far, the key end users of the project are:

- National Centre for Agricultural Research and Extension, Baqa'a, Jordan. Participants are: Dr Ghada Naber, Eng. Safa Mazahreh, Eng. Muna Saba.
- Ministry of Environment, Amman, Jordan. Participants are: Eng. Hussein Shahin, Eng. Raed Bani Hani, Eng. Ahmad Shahin.

NATO Consultant : N/A

### Other Collaborating Institutions

- Badia Research Program (BRP) which is a UNCC funded program to rehabilitate degraded rangelands of Jordan. Key Participants are: Dr Marwan Suifan.
- Jordanian Society for the Desertification Control and Badia Development. Key participant: Eng. Nasser Abu Rumman.
- The Royal Jordanian Geographic Center (RJGC), Amman, Jordan. Key participant: Dr. Maria Khirfan.
- The National Committee to Combat Desertification, MoEnv., Amman, Jordan.

Intellectual Property (IP) Rights : N/A

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Abbreviations: ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer; EWSI: Evapotranspiration Water Stress Indicator; GIS: Geographical Information System; HU: Hashemite University; JUST: Jordan University for Science and Technology; MODIS: Moderate Resolution Imaging Spectrometer; RADAR: Radio Ranging and Detection; RJGC: Royal Jordanian Geographic Center; UNCC: United Nation Compensation Commission; UJ: University of Jordan.

SfP 983611

## **Desertification Observatory for Environmental and Socio-Economic Sustainability**

Project Co-Directors: Dr. Massimo Iannetta, ENEA CR-Casaccia, Rome, Italy (NPD)  
Dr. Ahmed Ould Abdel Vetaah, Ministry of Environment, Nouakchott, Mauritania (PPD)  
Prof. Sidoumou Zeinebou Mint, University of Nouakchott, Nouakchott, Mauritania  
Mr. Aichetou Traore, ONG AIDID, Nouakchott, Mauritania

Approval Date: 7 June 2010  
Effective Starting Date: 30 May 2011  
Duration: 3 years, until May 2014  
NATO Budget: EUR 273,600

### Abstract of Research

The Mauritania territory, extending for more than 1 million Km<sup>2</sup> between the Sahara desert and the Sahel region, has been experiencing climate variations and profound economic and social mutations, especially during the last thirty years, due to a series of long periods of drought.

In this project, we will apply remote sensing, GIS and climate modelling science and technology, exploiting both historical data and available geospatial data to perform advanced analysis in order to identify and characterize the interacting factors and processes which progressively lead to land degradation and desertification and, ultimately, set up surveillance systems. The main results of the project will be the establishment of a "centralised Observatory on climate trends and desertification", including a targeted GIS. This will enable a better knowledge and monitoring of the territory and of the undergoing processes, and ultimately the achievement of a more effective territory management policies and the implementation of appropriate adaptation/mitigation measures.

Development of desertification risk maps. The project will provide a comprehensive drought and environmental indices catalogue with the identification of historical drought years and events, their characteristics in terms of geographic location and spatial and temporal extend, severity, thresholds, and impacts on several drought prone economic sectors. Based on this environmental database, a desertification assessment and mapping will be achieved. In the implementation of this database, GIS technology will be applied as an essential tool to address important aspects of environmental monitoring. GIS can in fact store both spatial and non-spatial data and allow users to manipulate, retrieve and analyse these data to obtain information useful for environmental assessment and management. The local offices of environmental protection department will serve as end-users and will guarantee the connection with all the country zones for products dissemination.

Operational monitoring of drought impacts. Thematic maps will then be produced to monitor the hydrological stress based on multi-source data (satellites, re-analysis etc) and on SVAT models. Monthly reports will be released.

### Major Objectives

The project shall improve access to, and the use of, remote sensing, GIS and modelling tools for climate trends and desertification assessment and monitoring and for natural resource management at national, regional and community levels. The end result of the project will be the setting up of a Desertification Observatory for environmental management. The Observatory will further its aims by integrating remote sensing, meteorological modeling and GIS technologies, and will allow the end-user (the Environmental Protection Department of Mauritania, EPD) to dynamically assess long term drought risk and desertification risk and to implement appropriate interventions. To this end, the project will map current drought and desertification risks in Mauritania, and will set up the hardware, software and expertise needed for its dynamic update. Participatory activities carried out throughout Mauritania will foster awareness about desertification and encourage proper behaviour of local communities in cooperation with the local offices of the EPD.

### Overview of Achievements since the Start of the Project until 30 September 2011

The first six months of the project have been focused in the setting and purchasing of the hardware equipments in Mauritania. All the Institutions involved (the Department of Environment, the University of

Nouakchott, and the ONG AIDID) were activated for the search and establishment of the hardware equipment, suitable to support selected software for meteorological modeling and GIS technologies. In the specific, the list of the equipment request was focused on the setting of a net of PCs, including projectors and printers to be used for recording data and to implement training courses for the scientists and the technical personnel involved in the project. In addition, GPS and video-cameras have been purchased in order to improve field data recording.

Payments through NATO Funds: EUR 10,290

#### Milestones for the Next Six Months

During the next six months we will complete the infrastructure needed for the Observatory and the training activities (Milestones M1 and M2). Young researchers to be trained will be hired and training will begin (M3). Participatory activities to sensitize the local population will also begin.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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Abbreviations: GIS- Geographic Information System; SVAT models- Surface-Vegetation-Atmosphere Transfer models

## Remediation processes in uranium and other mining explorations

Project Co-Directors: Ruth Pereira, University of Aveiro, Aveiro, Portugal (NPD)  
 Mohamed Ksibi, Lab. Water, Energy and Environment LR3 (ENIS), Sfax, Tunisia (PPD)  
 Abdelmajid Haddioui, University of Sultan Moulay Slimane, Beni-Mellal, Morocco  
 José Sousa, IMAR-CIC, University of Coimbra, Coimbra, Portugal  
 Jörg Römbke, ECT Oekotoxikologie, GmbH, Flörsheim am Main, Germany

Approval Date: 14 November 2008  
 Effective Starting Date: 1 March 2009  
 Duration: 3 years, until March 2012  
 NATO Budget: EUR 294,500

### Abstract of Research

Great amount of wastes rich in metals and radionuclides, which can be dispersed into surrounding lands and water resources, are the major concern posed by ore exploration areas worldwide. Whenever as possible, the mitigation of risks, the recovery of landscape and of land uses has been carried out through highly expensive engineered based methods, difficulty supported by national governments and private companies. More recently, phytoremediation has been suggested as the most eco-friendly solution, however few reports exist describing the success of such methodology when applied in large-scale scenarios, probably related with difficulties to maintain the healthy growth of plants on contaminated soils. Hence the exploration of relationships between plants and bacteria growing on the rhizoplane and endorhizosphere could be a promising strategy to overcome mail difficulties found until now. We have hypothesized that the inoculation of new plantlets with metal resistant strains of bacteria or mobile elements (plasmids) carrying genes of metal resistance, previously isolated from plants already living in contaminated areas, will be able to grow on health conditions on contaminated soils from uranium and other mining areas, and to contribute for metal immobilization on their tissues. To test this hypothesis this proposal describes several tasks that will be carried out in three contaminated sites: in the vicinity of a phosphogypsum pile in Sfax, Tunisia; an iron mine in Ait Amar Morocco and in a uranium mine in Cunha Baixa, Portugal. The project will culminate with the validation of the ability of inoculated plantlets to grow on contaminated soils, both under laboratorial and field conditions.

### Major Objectives

- To characterize the rhizoplane/endorhizosphere bacterial communities and isolate mobile genetic elements (plasmids) involved on metal resistance of hyperaccumulating plants from study sites.
- To inoculate the roots of small plantlets from selected species with bacteria endophytes and assess their ability to promote plant growth in contaminated soils, under green house and *in situ* experiments.
- To assess the effectiveness of successfully grown plants in promoting the mitigation of soil toxicity to soil microorganisms and invertebrates.
- To propose a new approach for reforestation and subsequent remediation of contaminated areas.
- To contribute for young scientists solid training through the offer of experiences with all the research teams involved.

### Overview of Achievements since the Start of the Project until 30 September 2011

Since the beginning of the project the isolates from plants living in the mines from Portugal, Tunisia and Morocco have been characterized and are prepared for the inoculation on plants. Further tests to select the plant species have been performed in Portugal, and two species have been evaluated: *Fraxinus angustifolia* and *Salix atrocinerea*. These assays will be done in Tunisia. And for Morocco tests will be performed in Portugal. Further all the exotoxicological assays previewed for the risk assessment of the three contaminated sites have been done and risk calculations are being performed. The training of students is still ongoing with success. Two students have finished their master degree thesis, one from Tunisia (Sirine Bouguerra) and the other from Portugal (Jorge Nuno Martins).

The communication with end-users has been reinforced and at this moment two companies, one from Tunisia and the other from Portugal have expressed their interest in applying the methodologies developed in this project.

Payments through NATO Funds: EUR 154,043.86

#### Milestones for the Next Six Months

- Task 5 (Contribution of endophytic/rhizoplane bacteria and plasmids bearing metal resistance genes for plant health) will start for Portugal.
- Young scientists training in Averito, Coimbra and Flörsheim laboratories.
- Former papers prepared for publication.
- Abstracts will be submitted to international meetings for the divulgation of data and of the project.

#### Implementation of Results

The company responsible by the TAPARURA project in Tunisia, which has restored the area of the old phosphogypsum pile in Sfax, has showed its interest in applying the methodologies of the project, after one of its members has participated in a workshop in January 2011. Contacts with this company continue, as they are giving advice about the best plant species to select, for inoculating bacteria.

NATO Consultant : N/A

#### Other Collaborating Institutions

Potential End-users:

- Commune Rurale de Beni Ouakil  
Province de Béni Mellal, Royaume du Maroc
- Association Oralité, Conte pour l' Amitié, le Dialogue et le Développement,  
Béni Mellal, Maroc
- EDM, Empresa de Desenvolvimento Mineiro, SA  
R. Sampaio e Pina, 1-5º Esqº, 1070-248 Lisboa, Portugal  
<http://www.edm.pt/html/bemvindo.htm>
- Société D' Etudes et d' Aménagement des Côtes Nord de la Ville de Sfax  
SEACNVS, 11 Rue Zamakchari, Cité el Maaref El Bosten, 3002 Sfax  
Tel : +216 74 437 352 | Fax : +216 74 437 362
- Cotusal, Sfax  
Route De Gabes Km 1 Route De Sidi Salem, 3018 Sfax  
Tel : +216 71 347 666 / 74 467 521 | Fax : +216 71 349 861 / 74 467 100

Intellectual Property (IP) Rights : N/A

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SfP 982812

## **Inventory, Monitoring and Analysis of Obsolete Pesticides in Armenia for Environmentally Sound Disposal**

Project Co-Directors: Prof. Dr. Ivan Holoubek, RECETOX, Masaryk University, Brno, Czech Republic (NPD)  
Dr. Anahit Aleksandryan, Ministry of Nature Protection, Yerevan, Armenia (PPD)

Approval Date: 9 April 2009  
Effective Starting Date: 12 April 2009  
Duration: 2 years, until April 2011  
NATO Budget: EUR 213,000

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Information about the SfP Project through Internet: not yet

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### Abstract of Research

Problems relevant to waste management, including obsolete pesticides, polychlorinated biphenyls (PCBs)-containing oils, etc. are of priority, urgency and importance for Armenia.

The complexity of resolving these problems is aggravated by the fact that in Armenia there are lacking specialized sites for toxic waste treatment/decontamination of toxic waste, industrial facilities for processing and destruction of hazardous wastes. No specialists trained/qualified in this specific area are in place.

Proceeding from the above mentioned, in order to ensure environmental security the main objective of this Project is a study on the environmental situation, pesticides-associated risk for human health and the environment and elaboration of scientifically grounded recommendations on minimizing the their risks and the unfavorable impact to human health and the environment.

The following tasks should be set forth and resolved for achievement of the stated goal:

- Inventory taking on expired pesticides stocks at the territory of the Republic of Armenia and mapping of potentially highly polluted sites.
- Establishing a laboratory with specialized personnel on environmental analysis.
- Monitoring on residual amounts of pesticides in environmental media (soil, surface waters), food stuffs and biomedica.
- Strengthening the current status of technical basis for analytical investigation.
- Obsolete pesticides risks assessment/reduction to ensure environmental security.

### Major Objectives

In order to ensure pre-requisites of environmental security and conditions for environmentally sound management of hazardous waste, including that of obsolete pesticides it is necessary to perform the following:

- Arrangement and taking inventory on obsolete pesticides at the territory of Armenia.
- Establishment of an accredited analytical laboratory for identification and determination of pesticides and other chemicals in environmental media, food-stuffs and biomedica.
- Training and re-training specialists to perform analytical studies.
- Identification of obsolete pesticides.
- Monitoring on residual amounts of pesticides in environmental media (soil, surface waters) and food-stuffs, biomedica.
- Assessment of risks posed by pesticides to human health and the environment.
- Elaboration of scientifically substantiated recommendations on minimizing the risks and environmentally sound disposal of obsolete pesticides in order to ensure environmental security of the general population.
- Arrangement and holding trainings/workshops for different target groups (decision-makers, managerial staff, officials, workers, farmers, etc.), women, children and less educated persons on issues relevant to hazards and risks, assessment of risk connected to pesticides.

## Overview of Achievements since the Start of the Project until April 2011

Activities in the evaluated periods:

- Training of Armenian specialists – preparation of participation in the RECETOX, Brno, CR, January 2011.

Payments through NATO Funds: EUR 153,500

### Milestones for the Next Six Months

- Preparation of the establishment of accredited analytical laboratory.
- Training courses on the specific aspects of the project.
- Standard operation procedures for sampling and analysis.

### Implementation of Results

Country users were informed about all project goals, steps and outputs during the Inception Workshop and will be continuously informed about the project progress, especially in the connection with the actualisation fo the National implementation plan of the Stockholm Convention on POPs.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

Intellectual Property (IP) Rights : N/A

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SfP 983931

## **Sustainable management of toxic pollutants in Central Asia: Towards a Regional Ecosystem Model for Environmental Security (SUS-CA-REM)**

Project Co-Directors: Prof. Sezai Sarac, Istanbul Technical University, Turkey (NPD)  
Prof. Sarkyt Kudaibergenov, Kazakh National Technical University, Almaty, Kazakhstan (NPD)  
Prof. Romeo Ciobanu, Technical University of Iasi, Romania (Co-Director)  
Prof. Alexander Koch, Technical University of Munich, Germany (Co-Director)  
Dr. Aktam Khalmanov, Samarkand State University, Uzbekistan (Co-Director)  
Dr. Zainiddin Muhidinov, Chemistry Institute of Tajikistan Academy of Sciences, Dushanbe, Tajikistan (Co-Director)

Approval Date: 1 October 2010  
Effective Starting Date: 1 April 2011  
Duration: 3 years, until March 2014  
NATO Budget: EUR 270,000

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Information about the SfP Project through Internet: not yet

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### Abstract of Research

The project has the aim to conduct a regional study upon the major sources of contamination and actual effects upon environment, including polluted sites evaluation vs. hydro-physical and climatic context, and implications for economic, cultural and political relations in the region. The enhancement of laboratories and personnel training of the involved research centres in the Central Asia region- towards establishing a regional infrastructure, will be followed by dedicated research and studies, demonstration activities of laboratory tests of contaminated samples and dissemination actions. A novel dynamic **Regional Ecosystem Model for environmental security** will be developed, evaluated with real case studies and implemented in cooperation with the end-users for the purpose of sustainable management and elimination of toxic pollutants in Central Asia. A compendium of cross-border activities related to remedial actions at ecosystem level will be promoted with the national and regional policy makers.

### Major Objectives

- The project will conduct to a regional study upon the major sources of polychlorinated biphenyls (PCBs) contamination and local and regional pollution effects, by chromatographic and spectroscopic methods.
- These results will lead to a regional ecosystem model with decision making mechanisms, for relevant management practices related to environmental security and efficient implementation of the results with end-users.
- Establishment of regional capacities of Central Asian Republics on polluted by PCB regions.
- Preparation of advanced national and regional actions related to methodologies and research methods, specialists' formation.
- To initiate real survey actions related to persistent toxic pollutants contamination in soil, water, regional food products, mainly the PCBs.
- To extend dynamic environment security evaluation, in connection with local climate and socio-economical conditions, by novel Regional Ecosystem Model.
- To help implementing adequate best management practices (BMPs) to prevent potential larger scale accidental contamination and/or use of damped POPs for local terrorist attacks.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Details of Gas Chromatographic and Spectroscopic screening methods for the polychlorinated biphenyls (PCBs) are searched, the measurement technique is based on high resolution gas chromatography – and FTIR spectroscopic methods are established, Gas Chromatographic and Spectroscopic Equipment purchase and installations were mainly performed.
- Members of local scientific boards consisting of interdisciplinary and industry representatives of Foundation discussed during this period in technical meetings.

- The capacity of equipment to develop the novel comparative test methodologies, and perspectives to carry out researches in the field of contaminated soil and water evaluation, remediation and sustainable development were discussed.
- Three specialized laboratories have been set up in Kazakhstan, Uzbekistan and Tajikistan to test the polluted by PCB sites (soil, water and foodstuff).
- Project Co-Directors and team members participated at several International and National Conferences and Symposiums.
- May 20-21, 2011 International Workshop on “Specialty Polymers for Environment Protection, Oil Industry, Bio-, Nanotechnology and Medicine” at Kazakh National Technical University, Almaty, Kazakhstan was organized.
- Project co-director Dr. Aktam T.Khalmanov successfully took part in IV Republic fair of innovation ideas, technologies and projects and has received the certificate of very good innovation ideas « An powerful ultraviolet pulsed nitrogen laser with two active volumes » on Science and education from April 15-20, 2011 (Tashkent, Republic of Uzbekistan).
- Project co-director Prof. Zayniddin Muhidinov and Mr. Roustam Shachmaev (supporting personnel) took part in the ITP training on Strategies for Chemicals Management from 6 – 28 September 2010 in Stockholm, Sweden and 9-13 May 2011 in Kiev, Ukraine organized by KEMI & SIDA.
- Prof. Muhidinov has participated in SETAC 21-Europe Conference May 14-21, 2011 Milan, Italy, where acquiring an experience and knowledge at SETAC conference for Environmental Toxicology and Chemistry. Travel was financed by ISTC, Totally 3 papers were published in English in peer-reviewed journals, 40 abstracts of papers were published in materials of International and National Conferences.

Payments through NATO Funds: EUR 142,220

#### Milestones for the Next Six Months

Milestones of Kazakh team for the next six months are:

1. Creation of the web-site.
2. Training of Dr. Gulnur Tatykhanova at MIT (USA).
3. Training of young scientists (including master course students) to work on purchased instruments.
4. Collection of database on polluted by PCBs sites of Kazakhstan.
5. Expedition to Ust-Kamenogorsk city (Kazakhstan) for sample splitting of soil, water, bottom sediments, and foodstuff.
6. Development of chromatographic and spectroscopic methods for determination of PCBs in soil, water, bottom sediments, and foodstuff.
7. Organization of local seminar on state-of-art of PCBs polluted territory of Kazakhstan in Almaty with participation of representatives from the Ministry of environment protection, end-user and NGOs.
8. Publication of activities in regional newspapers.

Milestones of Uzbek team for the next six months are:

1. Training of Dr. Aktam Khalmanov at Department of Chemistry, University of Florida, Gainesville, USA.
2. Participation on International conference of PITTCON 2012 in ORLANDO, FLORIDA
3. Training of young scientists (including master course students) on GC, Analyzer L2000DX, Digital Storage Oscilloscope TDS2022C Tektronix, 827pH lab Metrohm and Zero Air Generator instruments.
4. Organization of local seminar on determination of PCB in soil and water with participation of representatives from Committee for Nature Protection of The Samarkand Region and end-user.
5. Organization of Workshop in March-April, 2012 at Samarkand State University with participation of representatives from Turkey, Kazakhstan, Germany, Romania and Tajikistan.
6. Organization joint scientific papers with colleagues (TUR, ROM, GER, TAJ and KAZ).

Milestones of Tajik team for the next six months are:

1. Data base collection from PCB contaminated areas, using implemented projects for monitoring of POP's chemicals in Tajikistan.
2. Organization of sampling around of Aluminum factory from PCB containing soil, water sediment and foodstuff.
3. Developments for the method of extraction and concentration of PCB from soil and water sediment samples.
4. Development of chromatographic and spectroscopic methods for determination of PCBs in soil, water, bottom sediments, and foodstuff.

5. Training of young scientists (including master course students) on GC and FTIR spectroscopic instruments.

### Implementation of Results

As the Project in its beginning stage no any transfer of project results to end-users was performed. However the role, activity and responsibility of end-users are outlined below.

1. Ministry of environment protection of Kazakhstan, Astana, Kazakhstan, on the basis of our results will propose the governmental bodies for promotion of the Stockholm Convention on POPs.
2. State organization "Infracos-Ecos" National Space Agency of Kazakhstan, Almaty, Kazakhstan, is responsible for dissemination of developed technology in Kazakhstan, and will act as *first end-user*, in charge with mobile laboratory testing for soil, water and air of polluted areas and PCB elimination strategy. Its main activity is to exchange of experience for specialists, on-site training cooperation and dedicated measurements support, in order to strengthen the Kazakh national institutional and technical capacity to undertake implementation of the national plans for reduction and elimination of toxic pollutants.
3. NGO "Farmers of Kazakhstan" Foundation, Almaty, Kazakhstan. Public Fund "Kazakhstan Farmers" is interested in application of project results for analysis and remediation of soils polluted by POPs pesticides and herbicides.
4. Limited Liability Company "Kazecoproject, Almaty, Kazakhstan. The main activities of LLC "Kazecoproject" are to develop ecological projects, providing of ecological monitoring, laboratory analysis and marine investigations. LLC "Kazecoproject" is interested in application of project results to disseminate them at regional, national and international levels.
5. The end users from Uzbekistan (Samarkand Agricultural Institute Ministry of Agriculture and Water Resources of Uzbekistan and Committee for Nature Protection of The Samarkand Region) are interested in application of the NATO SfP 983931 project results and special laboratory (instruments) for analysis PCB in water and soil.
6. As end user from Tajikistan for the NATO SfP 983931 project implementation was chosen the Centre for Implementation of Stockholm Convention from the Committee for Ecology, Tajikistan Republic (CISCT). The CISCT presenting National Implementation Plan on POPs in Tajikistan, which was established on the base of Statement of Government of the Republic of Tajikistan #17-p dated 3rd of March, 2003 "About approval the Working Group on elaboration of Action Plan for reduction of persistent organic pollutants uses in the Republic of Tajikistan" and the Memorandum, signed by UNEP and Ministry of Nature Protection of the Republic of Tajikistan on 4th of September, 2003 on elaboration of Project "Enabling Activities for the Development of a National Plan for Implementation of the Stockholm Convention on POPs in Tajikistan" by financial support of GEF. The project plan closely will work with above projects task activities and will make a contribution to that in field of chemical analysis and mapping of the polluted areas.
7. Ministry of environment protection of Uzbekistan, Ministry of environment protection of Tajikistan

NATO Consultant: N/A

### Other Collaborating Institutions

- Infracos-Ecos- National Space Agency of Kazakhstan, Almaty, Kazakhstan
- Samarkand Agricultural Institute Ministry of Agriculture and Water Resources of Uzbekistan and Committee for Nature Protection of The Samarkand Region, Uzbekistan
- NGO "Farmers of Kazakhstan" Foundation, Almaty, Kazakhstan
- Committee for Ecology, Tajikistan Republic (CISCT)

Intellectual Property (IP) Rights: N/A

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Abbreviations: UV-Vis: Ultraviolet-visible; FTIR: Fourier transform infrared ; POP : persistent organic pollutant ; NGO : national governmental organization ; CISCT : Committee for Ecology, Tajikistan Republic ; GEF : Global Environment Facility ; UNEP : United Nations Environment Programme ; GC : Gas Chromatography ; Infracos-Ecos: National Space agency of the Republic of Kazakhstan



## Seismic Hazard and Risk Assessment for Southern Caucasus-Eastern Turkey Energy Corridor

Project Co-Directors: Prof. Erdal Safak, Kandili Observatory and Earthquake Research Institute, Istanbul, Turkey (NPD)  
Prof. Tamaz Chelidze, M. Nodia Institute of Geophysics, Tbilisi, Georgia (PPD)  
Dr. Arif Akhundov, Co-Director, Ministry of Emergency Situations, Baku, Azerbaijan

Approval Date: 15 July 2008  
Effective Starting Date: 1 December 2008  
Duration: 3 years, until December 2011  
NATO Budget: EUR 325,000

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Information about the SfP Project through Internet:  
<http://www.koeri.boun.edu.tr/deprenmmuh/nato/project/index.html>

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### Abstract of Research

The Southern Caucasus- Eastern Turkey energy corridors are formed by several critical pipelines carrying crude oil and natural gas from Azerbaijan, via Georgia, to Turkey and world markets. In civil engineering literature, such structures are commonly termed as “Lifelines” for the cities and countries they cross, because of their importance and the consequences of any damage to them. The two most important of these pipelines are the Baku-Tbilisi-Ceyhan (BTC) Crude Oil Pipeline and the Baku-Tbilisi-Erzurum (BTE) Natural Gas Pipeline. These two pipelines cross major seismic zones that have experienced large earthquakes in the past but, to our knowledge, none of these pipelines has ever been evaluated comprehensively (other than the standard code-based design studies) for their seismic safety and risk. None of the pipelines has any type of seismic monitoring system.

The current project that has been carried out with Turkish, Georgian and Azerbaijan researchers aims to identify the vulnerable segments of the Baku-Tbilisi-Ceyhan (BTC) Crude Oil Pipeline and the Baku-Tbilisi-Erzurum (BTE) Natural Gas Pipeline to earthquakes, and provide mitigation strategies by performing a comprehensive seismic hazard and risk study for the pipelines.

### Major Objectives

- To assess the seismic hazard in Azerbaijan, Georgia and North Eastern Turkey
- To evaluate the seismic safety of the pipelines
- To develop efficient seismic risk monitoring and mitigation strategies
- To improve environmental security in this part of the world.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Organisation of the first kick-off meeting in January 2009, in Baku, Azerbaijan.
- Purchase request /delivery of all instruments for Partner Countries.
- Purchase /delivery of softwares necessary for seismic hazard assessment (EZ-FRISK) and site response analyses (SHAKE2000) .A special permission from Risk Engineering Inc, for modification of seismic hazard software (EZ-FRISK) to be available for run in all three country’s land area.
- Extension of EZ-FRISK Software license for one year.
- Determination of the study area/ cell area for seismic hazard and risk analyses.
- Compilation of active fault maps, geology, topography, geotechnical maps and registration of maps to the GIS system.
- Compilation of seismicity catalogs and construction of a complete homogeneous catalog.
- Compilation of available geotechnical information.
- Compilation of structural characteristic of pipeline.
- Calculation of earthquake statistics and recurrence characteristics of each seismic source.
- Preliminary field experiments at Georgia (with site characterization purpose).

- Participation & presentation by Georgian and Turkish Participants at several International Conferences (in Turkey, Azerbaijan, Georgia, France, Republic of Macedonia, Italy and USA).
- Project internet web site was prepared and is now available under Bogazici University web server : <http://www.koeri.boun.edu.tr/deprenmmuh/nato/project/index.html>
- A seismic hazard & site response analysis training course as well as training on seismic monitoring instruments were held in 19-23 October 2009 in Istanbul. 5 trainees from Georgia(3) and Azerbaijan(2) and 6 lecturers from Turkey have attended to course.
- Organisation of the first annual progress meeting in 2010, in Tbilisi, Georgia.
- Probabilistic seismic hazard maps for each country were calculated showing peak ground accelerations, velocities, displacements and spectral accelerations at 0.2, 1, 2, 4 sec periods for 10% and 2% probabilities in 50 years.
- Deterministic seismic hazard maps were prepared by Georgia.
- Equipments purchased were tested in laboratories and on the field.
- ERP-1 and GEODE 24 stations were deployed in Shirvan, and engineering-geology and geophysics investigations were conducted.
- The ambient noise recorders (BAZALT4x) were deployed on three storey's of the Institute of Geophysics, Tbilisi.
- Site amplification maps of the study area in Georgia were prepared based on geological classification.
- Georgian team performed field works at 30 points alongside the BTC pipeline. Site effects at each point were calculated through the SHAKE2000.
- Georgian team performed site classification according to EC-8 scheme based on geophysical data.
- Five participants (2 researchers from Azerbaijan, 2 researchers from Georgia and 1 researcher from Turkey) attended to European Geophysical Union Assembly, April, 2011 in Vienna and presented project results in 4 different papers.
- A participant from Turkey attended to American Geophysical Union Assembly in December 2010, in USA.
- Site independent seismic hazard assessment for Azerbaijan has been completed.
- Shear wave velocity estimation was performed at 12 locations in Azerbaijan with RAS-24, which were purchased within the project.
- Probabilistic seismic hazard analysis has been completed by Turkish team for the whole study area covering 3 countries.
- Controlling ground motions for the risk analysis have been decided.
- Organisation of annual progress meeting in 2011, in Baku, Azerbaijan.
- Deterministic seismic hazard analysis has been completed for 3 countries.
- Site Dependent Probabilistic and deterministic seismic hazard analysis have been completed.

Payments through NATO Funds: EUR 221,783

#### Milestones for the Next Six Months

- Preparation of a combined risk assessment maps.
- Preparation of Final Report

#### Implementation of Results

Probabilistic and Deterministic Seismic hazard of the region have been calculated and in a short while hazard maps will be available to transfer to the end-users. All co-director are in close contact with end-users and all data are ready to use by end-users, if they are required.

Names of the End-users are:

- Ministry of Emergency Situations, Baku, Azerbaijan.
- Ministry of Ecology and Natural Sources, Baku, Azerbaijan
- Ministry of Environmental Protection and Natural Resources of Georgia, Tbilisi, Georgia
- BOTAS, Ankara, Turkey

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Abbreviations: BTC: Baku-Tbilisi-Ceyhan ; BTE: Baku-Tbilisi-Erzurum ; BOTAS: Petroleum Pipeline Corporation ; GIS : Geographic Information System ; SfP: Science for Peace

SfP 983828

## Seismic Upgrading of Bridges in South East Europe by Innovative Technologies

Project Co-Directors: Prof. Dr. Uwe Dorka, University of Kassel, Kassel, Germany (NPD)  
Prof. Dr. Danilo Ristic, IZiIS, Skopje, FYR Macedonia (PPD)  
MSc. Arian Lako, Civil Engineering Faculty, PUT, Tirana, Albania  
Prof. Dr. Damir Zenunovic, FMGCE, Tuzla, Bosnia & Herzegovina  
Prof. Dr. Radomir Folic, Faculty of Techn. Sciences, Novi Sad, Serbia

Approval Date: 15 December 2009  
Effective Starting Date: 8 February 2010  
Duration: 3 years, until February 2013  
NATO Budget: EUR 282,000

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Information about the SfP Project through Internet: <http://isubridge.vacau.com>

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### Abstract of Research

The high seismic risk to transportation networks in Southeast Europe (SEE) is a serious threat to public safety, sustained economic and social development and security in the region. Most of 15000 existing bridges, which must guarantee continuous functionality of the road networks, are constructed as non-seismic and are older than 40 years. They are highly vulnerable to seismic loads and require immediate, reliable and cost-effective seismic upgrading. The project end-product actually represents creation of new and innovative bridge seismic protection system by introducing improved seismic isolation technologies that are capable of providing efficient protection of existing and new bridges against earthquake damage. In the development phase, extensive laboratory tests of new components and seismic isolation devices will be carried out. In the final stage, the constructed reduced-scale bridge models with new seismic isolation system will be laboratory tested on a special seismic shaking table simulating recorded real earthquake ground motions. The end-result of this project represents new seismic isolation and seismic protection concept that technologically supports and helps the countries and responsible governmental ministries to achieve efficient seismic upgrading of highway bridges and effective functionality improvement of the integral highway transportation systems.

### Major Objectives

- Development of advanced method for structural state diagnosis (SSD-Method), providing efficient safety evaluation of existing bridge structures under operational and extreme seismic loads.
- Development of advanced method for selection of optimal bridge seismic upgrading technology (BSU-Method), representing essential and important tool for actual decision making purposes.
- Development and testing of prototypes of new hysteretic energy dissipation components (EDC) and hysteretic energy dissipation devices (EDD).
- Development and testing of new bridge seismic isolation system integrating innovative concepts of Multi-Level Multi-Directional Seismic Energy Dissipation and Globally Optimized Seismic Energy Balance (ML-GOSEB-System).
- Establishment of advanced seismic design procedure involving application of ML-GOSEB system for seismic protection of new and existing bridges.
- Publishing the major project findings to stimulate usage of advanced seismic protection technology.
- Motivation of end users toward application of innovative seismic protection technologies.
- Mobilization of scientific potential in the region for advanced solving of complex seismic safety problems of existing and new bridges and promotion of permanent cross-border cooperation.
- Establishment of new regional seismic innovation network (ReSIN) for development and promotion of advanced technology for seismic protection of structures (as long-term NATO-project benefit).

### Overview of Achievements since the Start of the Project until 10 October 2011

- Bridge inventory have been successfully accomplished and presently selection of prototype bridges for experimental testing and theoretical study purposes in all participating countries is in progress.

- Advanced method for structural state diagnosis of existing bridges is in final development phase.
- Development of practical method for selection of bridge seismic upgrading technology is created.
- Basic design of the anticipated ML-MD hysteretic energy dissipation devices is accomplished.
- Main prototypes and testing conditions of the ML-MD hysteretic dissipation devices are completed.
- Test models of bridge prototypes with and without the new ML-GOSEB system have been defined.
- Development of original software is continued and purchase of available software is in progress.
- Project Web-presentation has been elaborated. Training of junior scientists is continued.
- New regional innovation network for promotion of seismic isolation technology (ReSIN) is initiated.

Payments through NATO Funds: EUR 45,387.00

### Milestones for the Next Six Months

In the course of the next six months activities will be realized according to Project plan, including:

- Processing of experimental results obtained from ambient vibration tests of representative bridges.
- Completion of development of method for structural state diagnosis of existing bridges.
- Completion of development of method for selection of bridge seismic upgrading technology.
- Construction and testing of ML-MD hysteretic energy dissipation components and devices.
- Design of bridge models planned to be experimentally tested on seismic shaking table.
- Software purchase and realization of related analytical studies.
- Publishing of selected project results on regular basis on the project web page.
- Training of young scientists, web maintenance, etc.

### Implementation of Results

The end-users of the project end-products and innovative results, resulting from realization of this innovative SfP project are competent governmental institutions, (corresponding ministries) responsible for the project domains and/or for the functioning of the road network in each individual country. The co-directors of this innovative SfP project successfully established initial cooperation (in each country) with respective institutions. The end-users in Macedonia are: 1) Government in General and 2) Ministry of Environment and Physical Planning; in Albania: 1) Ministry of Public Works, Transport and Telecommunication, and 2) Ministry of Environment, Forest and Water Administration; in B&H: 1) Federal Ministry of Transport and Telecommunication, and 2) Ministry of Environment and Tourism; and in Serbia: 1) Government in General, and 2) Provincial Secretariat for Architecture, Planning & Civil Engineering, Vojvodina, Serbia. In the course of project realization, cooperation will be extended.

NATO Consultant : N/A

### Other Collaborating Institutions

Some institutions and potential end-users are contacted (*In Macedonia: Skopje City Major, Mr. Koce Trajanovski, who supported the project as respected end-user responsible for all city existing bridges*). Their specific contributions are expected and will be included in next progress reports.

### Intellectual Property (IP) Rights

Some patent applications are not realized yet.

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Abbreviations:                   SSD-Method - Structural State Diagnosis Method ; BSU-Method - Bridge Seismic Upgrading Method ; ML-GOSEB System – New Multi-Level Globally Optimized Seismic Energy Balance System ; EDC – Energy Dissipation Component ; EDD – Energy Dissipation Device ; ReSIN – Regional Seismic Isolation Network (planned to be newly established)

SfP 983142

## **Geo-Environmental Security of the Toktogul Hydroelectric Power Station Region, Central Asia**

Project Co-Directors: Dr. Derek Rust, University of Portsmouth, Portsmouth, U.K. (NPD)  
Dr. Andrey Korjenkov, Institute of Communication and Information Technologies,  
Bishkek, Kyrgyzstan (PPD)  
Prof. Alessandro Tribaldi, University of Minal-Bicocca, Milan, Italy

Approval Date: July 2008  
Effective Starting Date: 1 October 2008  
Duration: 4 years, until September 2012  
NATO Budget: EUR 250,000

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Information about the SfP Project through Internet: [www.toktogulgeoenvironemnt.com](http://www.toktogulgeoenvironemnt.com)

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### Abstract of Research

This multidisciplinary research project involves close collaboration between NATO and former Eastern Block geoscientists to analyze potential threats to the security of the Toktogul region; with recommendations for measures to mitigate a range of threat scenarios. The region lies within the actively deforming Tien Shan mountain range, the northern expression of ongoing Himalayan collisional mountain building. This deformation most notably includes the poorly-known Talas-Fergana fault, a strike-slip structure bisecting the Toktogul region that displays similar features to the San Andreas fault. No significant earthquakes have been recorded on the Talas-Fergana in historical times but the fault clearly has the potential to generate a large earthquake in the future, together with a range of earthquake-related hazards such as landslides and sudden downstream flooding. Such flooding would mobilize uranium waste dumps downstream, a legacy from Soviet-era uranium mining and processing, contaminating the irrigated Fergana Valley. Understanding the nature, location and recurrence patterns of threats to the environmental security of this region, as well as ways of mitigating against these threats, is crucial to planning and ensuring continued economic development and political stability, including avoiding conflicts over water and power supplies, extensive pollution of irrigated lands, and opportunities for terrorist groups to make propaganda from disorder. The fragility of this political stability was demonstrated in April 2010 by the violent overthrow of the Kyrgyzstan government.

### Major Objectives

- To assess the geo-environmental security of the region centered on the Toktogul reservoir scheme and its planned extensions.
- To formulate scenarios of potential threats to the geo-environmental security of the Toktogul region and produce recommendations for mitigation measures to ensure the highest levels of security in the future.
- To disseminate findings from the project as widely as possible; to both the scientific community through conference presentation and via papers in peer-reviewed international journals and, especially for the mitigation recommendations, to the local and national agencies concerned with managing the area and its security.
- To leave an enduring legacy in the region through imparting knowledge and inspiration to young local researchers, and through providing scientific equipment that will benefit future nationally-led investigations.

### Overview of Achievements since the Start of the Project until 20 October 2011

- Compilation, analysis and digitization of archived seismic records and other data within the project GIS.
- Training of young Kyrgyz GIS researchers.
- Training visits by NATO scientists to Kyrgyzstan.
- Satellite remote sensing analysis of the project region.
- Analysis of stereo aerial photographs by NATO and Partner Country scientists to plan fieldwork.
- The first and second field seasons of work completed, including trenching investigations of active faults.
- Working up of data to present at conferences and to submit to journal editors, co-authored by Young

#### Scientists.

- Completion of a landslide susceptibility analysis and map for the Toktogul region.
- Completion of InSAR analysis of Toktogul region.
- Samples for <sup>14</sup>C and OSL dating collected and sent to laboratories for processing.
- Field deployment of portable strong-motion seismometers to analyse ground response to seismic waves.
- Field geological mapping aided by the project differential GPS equipment.
- Preliminary slope instability analysis, including results from coring lacustrine deposits produced by landslide-dammed lakes.

Payments through NATO Funds: EUR 173,414.85

#### Milestones for the Next Six Months

- Writing of journal articles based on analysis of results obtained from dating laboratories.

#### Implementation of Results

The last version (9.13) of the industry standard GIS software (ArcGIS) is being employed in a user-friendly output format in the project GIS to aid implementation of results. Links with additional end-users have been established, particularly following the change of government in October 2010. These include key staff at the Ministry of Extraordinary Situations in Bishkek and further afield (see below).

- Mr Kubat Boronov, Deputy Minister of Extraordinary Situations of the Kyrgyz Republic.
- Mr Anarkul Aitaliev, Head of the Agency of Atomic and Radiation Security, under the Ministry of Extraordinary Situations of the Kyrgyz Republic.
- Ma Zebinisso Ergeshevo, Head of the Department of External Relations of the Agency of Atomic and Radiation Security, under the Ministry of Extraordinary Situations of the Kyrgyz Republic.
- Prof. Kamichibeck Kojogulov, Director, Institute of Physics and Rock Mechanics, Kyrgyzstan.
- Dr. Kadyrbek Sakiev, Director, Institute of Geology, Kyrgyzstan.
- Mr. Kh. Abdulazizov, Vice-Minister, Ministry of Emergency Situations, Uzbekistan.
- Prof. Zarlick Bekboev, Deputy Head of President's Administration, Kyrgyzstan.
- Mr. Dastanbek Berdiev, Mayor of Administration of Toktogul Region, Kyrgyzstan.
- Mr. Obid Djuraev, Vice Minister, Ministry of Agricultural and Water Resources, Uzbekistan.
- Dr. Sergei Erokhin, Head of Engineering Geology, State Agency for Geology and Mineral Resources, Kyrgyzstan.
- Mr. Kodirjon Jakbarov, Head of Department, Ministry of Emergency Situations, Fergana Province, Uzbekistan.
- Mr. Abror Kosimov, Head of Department, Ministry of Emergency Situations, Andijan Province, Uzbekistan.
- Mr. Koshbay Masirov, Mayor of Dzhahal-Abad Oblast, Kyrgyzstan.
- Mr. Alexandr Markushkin, Deputy Chief, Department of Water Resources and Meteorological Measurements Centre of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet).
- Dr. Kamchibek Musuraliev, Head of Expedition, Kyrgyz Complex Hydrogeological Expedition, Kyrgyzstan.
- Mr. Bakhodir Salmanov, Head of Department, Ministry of Emergency Situations, Namangan Province, Uzbekistan.
- Mr. Bakyrudin Sartkaziev, Head of State Company "Electrical Stations", Kyrgyzstan.
- Dr. Alexander Strom, Assistant to President, International Consortium on Landslides, Institute of geosphere Dynamics, Moscow, Russia.

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Abbreviations: ASTER: Advanced Spectral and Thermal Emission Radiometer; GIS: Geographic Information Systems; InSAR: Synthetic Aperture Radar Interferometry; KIS: Kyrgyzstan Institute of Seismology  
PGA: Peak Ground Acceleration; RMR: Rock mass Rating; SRTM: Shuttle Radar Topography Mission

SfP 983287

## Landslide Susceptibility Assessment in the Central Part of the Republic of Moldova

Project Co-Directors: Assoc. Prof. Dr. Murat Ercanoğlu, Hacettepe University, Ankara, Turkey (NPD)  
Dr. Nicolae Boboc, Institute of Ecology and Geography, Chisinau, Moldova (PPD)

Approval Date: 14 November 2008  
Effective Starting Date: 25 March 2009  
Duration: 3 years, until March 2012  
NATO Budget: EUR 226,500

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Information about the SfP Project through Internet: <http://natosfp983287.eu5.org/>

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### Abstract of Research

Landslides are one of the major natural hazards in Turkey and Moldova as they often result in the destruction of infrastructure, buildings and sometimes even loss of life. The geological, geomorphologic and climatologic similarities between these two countries allow the research teams to join their expertise and knowledge with the aim to make urban development and regional planning in Moldova safer. Therefore, it is believed that integration of the two teams' experience and knowledge under landslide topic will provide useful and beneficial information and economic benefits for the future works such as urban development and planning, engineering applications, land-use potential planning etc. in Moldova, based on the ideas of application of scientific principles to reach a better and peaceful world.

### Major Objectives

- To develop a reliable methodology for assessing landslide risks by applying Remote Sensing (RS) and Geographic Information Systems (GIS).
- To prepare a landslide inventory and database showing landslide characteristics.
- To produce landslide susceptibility maps and models for territorial planners and decision makers.

### Overview of Achievements since the Start of the Project until October 2011

Within the first year of the project, based on the project plan, the following activities have been accomplished entirely or partially (see Project Structure and Activities table):

- **Preparatory stage** with the following tasks: *selection of study areas; purchasing equipments and data; compilation of available reports and documents; building the web-page of the project.*
- **ASID stage** with the following tasks: *identification of landslides and other areas using satellite images; air photo interpretation and passive sensor satellite; digitizing works; change detection analysis; data integration.*
- **Field studies (1)** with the tasks: *in-situ observations and mapping; accomplishments of landslide inventory and database.*
- **Parametric assessments** with the tasks: *meteorological and earthquake data assessment; preparation of input parameters, parametric weight assessments; mathematical assessment.*

Payments through NATO Funds: EUR 142,026

### Milestones for the Next Six Months

- Purchasing equipment and data are planned to be made up for the lag occurred and finished.
- Updating the web-page of the project (on-going task during the entire project).
- Identification of landslides and other areas using satellite images.
- In-situ observation and mapping.
- Accomplishment of landslide inventory and database.
- Parametric weight assessments.
- Production of landslide susceptibility maps and validation of the results (at least in 1 key sector area).
- Mathematical assessments.
- Visual assessments (Field Studies 2).

- Arrangements, reconsiderations (if any).
- Implementation of results.

#### Implementation of Results

It is not possible to transfer the knowledge to the Project's End User (Ministry of Internal Affairs of Moldova, Civil Protection Service, Civil Protection and Emergency Situations Service, Chisinau, MOLDOVA) at the moment because of the fact that inventory studies has not been finished completely and no analyses could have been performed based on the inventory studies.

NATO Consultant : N/A

Other Collaborating Institutions : N/A

#### Intellectual Property (IP) Rights

There are no IP rights for the Project at the moment.

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SfP 983289

## Prevention of Landslide Dam Disasters in the Tien Shan, Kyrgyz Republic

Project Co-Directors: Hans-Balder Havenith, University of Liege, Liege, Belgium (NPD)  
Isakbek Torgoev, GEOP, GEOPRIBOR, I. Geomechanics, Bishkek, Kyrgyz Republic (PPD)  
Kanatbek Abdrakhmatov, KIS, Institute of Seismology, Bishkek, Kyrgyz Republic (Co-Director)  
Kasymbek Uulu Shailoo, DMF, Bishkek, Kyrgyz Republic (Co-Director)  
Alexander L. Storm, IGD, Moscow, Russian Federation (Co-Director)  
Miriam Kristekova, GEOPIN, Bratislava, Slovak Republic (Co-Director)  
Olivier Korup, Institut für Erd- und Umweltwissenschaften, Universität Potsdam, Germany (Co-Director)

Approval Date: 1 December 2008  
Effective Starting Date: 1 March 2009  
Duration: 3 years, until September 2012  
NATO Budget: EUR 275,600

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Information about the SfP Project through Internet:  
To be established in December 2011 on a server of Liege team.

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### Abstract of Research

We will carry out local and regional assessments of landslide dam hazards in the TS. We will study the stability of landslide-prone slopes and dam sites, both under static and seismic conditions (dynamic approach). Advanced numerical modeling techniques will be applied to simulate large deformations and mass movement development, landslide dam formation, upstream flooding, possible triggering of flood waves in the reservoir area and dam breaching and development of debris flows as well as sediment transport and discharge in rivers.

From these studies, landslide dam and flood wave hazards will be assessed. Risk scenarios will be developed through combination with quantitative estimates of structural vulnerability of exposed objects and infrastructure. On the basis of these risk scenarios and a qualitative evaluation of the population's resilience, mitigation/prevention measures will be proposed in collaboration with the MES of KR.

The work is divided into 3 sub-projects: Mapping Investigation and Monitoring; Hazard Assessment and Development of Risk Scenarios; Elaboration-Implementation of Disaster Prevention Measures.

### Major Objectives

Our goal is to prevent major disasters related to dams and flood waves generated by mass movements in the Tien Shan of the Kyrgyz Republic.

This will be achieved through

- Detailed regional and local investigation of existing and potential landslide dams and unstable slopes in areas of strategic interest: present and planned water reservoirs, nuclear waste storage areas.
- Numerical modelling of process sequences of (seismic) landslide triggering, dam formation, and flooding, also as a result of landslides falling into a water reservoir.
- Advanced 3D representation of hazard and qualitative risk scenarios considering short- and long-term socio-economic and environmental impacts.

Disaster prevention measures will be elaborated in close collaboration with the Ministry of Emergency Situations of the Kyrgyz Republic and experts of the neighbouring countries Kazakhstan, Uzbekistan, Tajikistan and China.

### Overview of Achievements since the Start of the Project until 10 October 2011

- 2 kick-off meetings bringing together all teams have been organized.
- 1<sup>st</sup> year project meeting in Liege attended by almost all participants has been a success. The summer 2010 surveys have been planned – but cancelled due to political problems in Kyrgyzstan.

- 2<sup>nd</sup> year project meeting in Bishkek attended by Belgian, Russian and Kyrgyz participants has been a success. The summer 2011 surveys have been planned (replacing the cancelled surveys of 2010 and adding new investigations).
- LADATSHA partners have presented works planned within our NATO SFP project at various conferences in Europe and Asia.
- A first field survey has been completed in September 2009 in Mailuu-Suu. The newly acquired equipment was tested to be prepared for the major survey in December 2009 – the recording of the Kambarata rock blasting and monitoring of adjacent slopes.
- The Kambarata survey has been completed. 4 NATO SFP LADATSHA teams have been participating in the survey of the blast.
- A landslide detection method has been developed on the basis of data mining technology and a susceptibility mapping method is now being implemented through the training of the PhD students of the project.
- The Minkush-Akkul surveys have been successfully completed in July-August 2011 (15 days involving up to 15 collaborators) as well as a field school in the Kekemeren valley.
- Three project directors will attend the World landslide Forum 2 in Rome, to organize special sessions and to give talks on dam and mass movement hazards. Other conferences attended by the partners are organized in Bishkek, Kyrgyzstan, Freiberg, Germany and Corinth, Greece.
- The second training of Kyrgyz stipendiaries has been completed in January-February 2011.

Payments through NATO Funds: EUR 215,401.40

#### Milestones for the Next Six Months

The next milestones are to make our work more visible to the scientific community through presentations and organized session at two conferences: Paleoseismicity-Corinth, Greece in September 2011 and the World Landslide Forum-Rome, Italy in October 2011.

In October, the installation of semi-permanent seismic stations on landslides close to the Kambarata 2 dam are planned. A project web-page will be installed on a server in Liege before December 2011. In January and February 2012, Almaz Torgoev will complete a training on numerical modeling in Liege.

#### Implementation of Results

For the Minkush site, the relocation of a nuclear waste tailing situated upstream a landslide slope has been proposed and should be completed as soon as external funds are available.

NATO Consultant : N/A

#### Other Collaborating Institutions

Dr. Ischuk from the Tajik Institute of Earthquake and Seismology is working on similar natural hazards problems in Tajikistan and had already been invited to the kick-off and the 1<sup>st</sup> year meeting.

#### Intellectual Property (IP) Rights

There are no IP rights for the Project at the moment.

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SfP 983516

## **Flood Monitoring and Forecast in Pripjat River Basin**

Project Co-Directors: Dr. Boris Minarik, Slovak Hydrometeorological Institute (SHMU), Bratislava, Slovakia (NPD)  
Dr. Alexei Iarochevitch, UCEWP, Kyiv, Ukraine (PPD)  
Dr. Iurii Nabyvanets, Ukrainian Hydrometeorological Institute (UHMI), Kyiv, Ukraine (Co-Director)  
Mr. Vladimir Korneev, Ctrl Res. Inst. For Complex Use of Water Resources, Minsk, Republic of Belarus (Co-Director)

Approval Date: 9 October 2009  
Effective Starting Date: 16 November 2009  
Duration: 3 years, until November 2012  
NATO Budget: EUR 260,000

### Abstract of Research

The main objective of the project is to enhance the flood monitoring in the Pripjat River Basin, to implement the contemporary modeling tools for flood forecasting and to predict the radionuclide transport in the Pripjat river basin for the different scenarios of the natural hazards and technological impacts. The project has a large procurement part: in its frame it is planned to initiate automatic hydrometeorological network by delivery and installation of two automatic water gauging stations, one for Ukraine and one for Belarus. These stations will provide in real time the data on water levels, air precipitation, air and water temperature. Such information will allow better flood preparedness in the region.

### Major Objectives

- to contribute to the development and maintenance of the automatic hydro-meteorological monitoring system by the installation of 2 hydrometeorological stations (one in each country) and 2 central servers (one in each country).
- to collect and to process the hydrographical data (river cross-sections and maps) that create a basis for the implementation of the distributed river hydraulics models.
- to implement the contemporary distributed flood forecasting models based on the Saint Venant equations for pilot river within Pripjat river basin (Styr river).
- to implement the radionuclide transport model to simulate consequences of the potential accident on Rivne NPP for the contamination of Styr river.
- to increase the level of skills and capacity in the organizations concerned with flood monitoring, forecasting and management by the providing of the specialized trainings and workshops.

### Overview of Achievements since the Start of the Project until November 2011

- Establishment of 50 river cross-sections and maps of inundation zones and radionuclides transfer.
- *For the first time for Pripjat basin and for the first time in Republic of Belarus* purchase of 4 automatic hydrometeorological stations, with one such station installed in Lutsk, Ukraine, in February 2011, and second installed in Hrenniki, Ukraine in October 2011 and the other two to be installed in autumn 2011 in Belarus (Lopatino and Pinsk).
- Purchase and installation of two central servers for the collection and analysis of data and the development of flood forecasting models at Hydrometeorological Centres in Belarus and Ukraine and installation of communication lines for the data transfer.
- Training of young technical personal at the Hydrometeorological Centres in Belarus and Ukraine.
- Modeling of rainfall-runoff processes based on historical records of flow and corresponding meteorological conditions and calculated hydrographs.
- GIS data processing in the distributed hydrological modeling for the Styr river watershed in the Pripjat River Basin, where Rivne Nuclear Power Plant is located
- Implementation of the contemporary flood forecasting models coupled for Ukrainian and Belorussian parts of the Styr River
- Development of nuclear emergency scenarios to simulate radionuclide transportation in case of an

- Media coverage in Belarus and Ukraine for the kick-off of the project and inauguration of automatic stations, which supported greatly the positive and non-military image of the NATO.

Payments through NATO Funds: EUR 211,790

#### Milestones for the Next Six Months

- Finalization of the negotiations regarding the exact places of the installation of the additional stations.
- Conduction of the tenders for installation of the three additional automatic hydrometeorological stations.
- Preparation of the request for the extension of the scientific part of the project.

#### Implementation of Results

The end users of the project are Brest Regional Hydrometeorological centre, Belarus and Volyn Oblast State Hydrometeorological center, Ukraine. They are both actively involved in the implementation of the project results: namely development of flood forecasting models and activities related to operation of the automatic gauging stations as well as trainings for young scientists.

#### NATO Consultant

Dr. Jaroslav Slobodnik, Director of Environmental Institute, Kos, Slovak Republic

#### Other Collaborating Institutions

- Kyiv National University of Taras Shevchenko, Geographical Department

Intellectual Property (IP) Rights : N/A

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Abbreviations: UCEWP: Ukrainian Centre of Water and Environmental Projects  
NPP: Nuclear Power Plant

SfP 983305

## **Development of a Monitoring System to Counter Manage the Risks of Subsidence Deformation on the Population of Tuzla (Bosnia)**

Project Co-Directors: Prof. Giovanni Gabbianelli, CIRSA Università di Bologna, Ravenna, Italy (NPD)  
Prof. Abdullah Basic, University of Tuzla, Tuzla, Bosnia & Herzegovina (PPD)  
Dr. Francesco Mancini, Politecnico di Bari, Italy  
Eng. Rusmir Salihovic, Tuzla Municipality, Bosnia & Herzegovina  
Dr. Sc. Mustafa Burgic, Tuzla Canton, Bosnia & Herzegovina

Approval Date: 14 November 2008  
Effective Starting Date: 10 March 2009  
Duration: 2.5 years, until December 2011  
NATO Budget: EUR 283,000

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Information about the SfP Project through Internet: [www.nato.int/science](http://www.nato.int/science) ; [www.demos.ba](http://www.demos.ba)

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### Abstract of Research

Tuzla is one of the densely populated urban areas in Bosnia and Herzegovina that has a long history of coal and salt exploration leaving behind abandoned mines. These mines are a hazard to the infrastructure and the population in this area due to ground deformation and sink holes. The project will bring together the huge amount of historical data on mining areas, their geotechnical and hydrogeological features, and integrate and produce an actual real picture of the situation by updating the existing geographical information system (GIS). The end-result will be detailed risk maps for endangered areas that will provide the basis for a long-term planning to monitor and mitigate the risk. The research will be done together with the communities in Bosnia and Herzegovina (representatives of the Tuzla Canton government and ministries, as well as the municipality of Tuzla) in order to increase their understanding of the problems and their feeling of ownership.

### Major Objectives

- Acquisition, analysis and proper interpretation of data.
- Elaboration of specific guidelines that will take care of hazards and risks zonation, physical damages and costs observations for the repair or replacement of buildings and other infrastructures.
- Define a geological model: Detailed geological map R 1:5000 of the endangered areas.
- Structural-tectonic relations of salt bearing and ambient layers, specially their overlaying strata.

### Overview of Achievements since the Start of the Project until March 2011

- Implementation of new data concerning the urban planning, very useful to a better definition of risk maps.
- Connection between the GPS network and the levelling network provided by the Salt Mine Company.
- Installation of the permanent stations in the Tuzla Municipality building and in the salt mine area.
- Installation of seismographs into the salt mine areas in order to monitor ground vibrations.

Payments through NATO Funds: EUR 184,107.85

### Milestones for the Next Six Months

Geophysics surveys such as seismic reflections-refraction and seismographs installation. Hydrogeological tracers investigation and divers installation into the piezometers.

### Implementation of Results

All the results obtained during the first six months have been interpreted as geographic maps which analyze and evaluate the severity of impact factors, such as subsidence, fractures and water table movements. The

identification the most endangered urban areas allows the local community in the town risk zonation, and will be soon acquired by urban planners.

NATO Consultant : N/A

Other Collaborating Institutions

Salt mine Company, Rudnik Soli D.D. Tuzla, Tuzla BIH

Intellectual Property (IP) Rights

There are no IP rights for the Project at the moment.

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SfP 983168

**Real-Time Remote Sensing for Early Warning & Mitigation of Disasters and Epidemics: The Mediterranean Dialogue Earth Observatory**

Project Co-Directors: Gilbert L. Rochon, PhD, MPH, Purdue Univ., W. Lafayette, IN, U.S.A. (NPD)  
Prof. Tajje-eddine Rachidi, Al Akhawayn University, Ifrane, Morocco (PPD)  
Prof. Chaker El Amrani, Abdelmalek Essaadi University, Tangier, Morocco (Co-Director)  
Prof. Dr. Gülay Altay, Boğaziçi University, Istanbul, Turkey (Co-Director)

Approval Date: 15 July 2008  
Effective Starting Date: 1 July 2011  
Duration: 3 years, until December 2014  
NATO Budget: EUR 280,000

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Information about the SfP Project through Internet: *to be provided*

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Abstract of Research

This project brings together a group of world class experts from research partner institutions in Turkey, Morocco (formerly from Egypt) and the USA, to plan and implement the NATO Science for Peace sponsored Mediterranean Dialogue Earth Observatory (MDEO), formerly proposed as the Kamal Ewida Earth Observatory (KEEO). The observatory comprises a network of real-time satellite remote sensing ground stations, to be established over the next 3 years in Morocco, with a tracking station for polar orbiting satellites at Abdelmalek Essaadi and Al Akhawayn Universities. This will also include a networked geostationary receiving station for the European Space Agency's Meteosat. The primary objective of the project is to facilitate early warning and mitigation of a wide range of biogenic and anthropogenic disasters. The project will also address mitigation of epidemics and epizootics, through identification and monitoring of infectious disease vector and reservoir habitat. Some examples of common concern among participating countries are flooding, storms, forest fires, climate change and its impacts, land use problems in agriculture, recent public health incidents, such as malaria, avian influenza, swine flu, as well as oil and hazardous chemical spills along the seashores. Archival and real-time remote sensing and generation of near-real-time spatial data products, utilizing high performance computing clusters, are planned throughout the life cycle of disaster management, including vulnerability assessment, infrastructure safeguards, early warning, emergency response, humanitarian relief as well as post-disaster damage assessment, reconstruction and societal recovery.

Two inevitable changes have been requested and agreed upon among all involved. First, due to the withdrawal of the Egyptian Universities from the project, as a result of the local governmental administrative restrictions that rendered the project impossible to implement in Egypt, the project is now to be implemented in Morocco. Morocco is another Mediterranean country which has many rich features that will impact the project very positively especially with two locations each with unique geographical characteristics and scientific challenges. Secondly, due to the transition of Dr. Gilber Rochon (NPD) from Purdue to Tuskegee University to become the 6<sup>th</sup> President for Tuskegee University, the project now relocated from Purdue to Tuskegee University with the agreement of Purdue University. The scientific emphasis of the project will, however, remain the same, with an additional training component that will be added to benefit scientists not only in Morocco but also in other neighboring countries.

The MDEO will provide real-time data from multiple earth observing satellites, near real-time data products and archival data access in support of interdisciplinary research, instruction and operational initiatives with respect to facilitating vulnerability assessment, early warning, impact mitigation and recovery for an array of anthropogenic and biogenic disasters including floods, storms, earthquakes, hazardous chemical and oil spills, famine, epidemics and epizootics.

Specifically, the Moroccan partners will engage in applications development, research and instructional collaboration with partnering resources from Bogaziçi University's Kandilli Observatory and Earthquake Research Institute (Istanbul, Turkey), with expertise in disaster mitigation as well as in real-time remote sensing and environmental sustainability. Since the primary focus of the MDEO will be the application of real-time satellite remote sensing for early warning and mitigation of biogenic and anthropogenic disasters, including epidemics and epizootics, there are multiple end-users for this project, including the WHO

Regional Office, as an ineluctable direct result of the interdisciplinary approach to effective disaster management.

This collaboration, with support from NATO's Science for Peace and Security program, will result in installation of instrumentation to facilitate timely notification, mitigation and humanitarian response to an array of natural and manmade disasters, initially focusing on meteorological disasters and on public health disasters. Moreover, the project will facilitate collaborative research on identification of best management practices (BMPs) and decision support, within the Moroccan context, for disaster vulnerability assessment, early warning, crisis management (i.e. in collaboration with government, multi-lateral agencies, NGOs, academia, press and the private sector), environmental impact assessment, emergency response, evacuation, disease outbreak containment, search and rescue, damage assessment and post-disaster reconstruction.

Finally, so as to share the benefits of this initiative with a wider audience, the project will develop a web-based Disaster Mitigation Hub, initially accessible, during data testing, to the initial partnering universities and collaborating end-users, then to additional universities and ministries, subsequently to NATO members, partners and dialogue countries and ultimately available to the global scientific community, in order to further the state-of-the-science with respect to disaster preparedness research and instruction, as well as to strengthen collective capacity for anticipation and response to meteorological, environmental and public health disasters.

### Major Objectives

- Convene Executive Committee
- Establish Advisory Board
- Develop bid specifications, solicit bids and select vendor for two remote sensing ground stations.
- Design Training Program to include Faculty, Students and Stakeholder/End-User Agencies.
- Implement Operational Groundstations primarily focusing on Disaster Early Warning & Mitigation.
- Demonstrate Utility of Remote Sensing for Disaster Management, Environmental Sustainability, Security, Public Health, Natural Resource Conservations & Sustainable Development.

### Overview of Achievements since the Start of the Project until 30 September 2011

- The Executive Committee met twice in October, 2008 in Cairo and also twice in April, 2009 in Cairo.
- The Advisory Board was established and expanded to include more stakeholders/end-users.
- Bid specifications were developed by Dr. Joseph Quansah, Dr. Souleymane Fall, Dr. Chadia Affane Aji and Dr. Gamal El Afandi in collaboration with Dr. Mohamed Shokr of Environment Canada.
- Plans were developed for the training program and specific target audiences were identified.
- The project is on schedule to issue a Request for Proposals from qualified vendors for groundstations.
- The Co-Directors held individual meetings with key stakeholders to ascertain their need for spatial-temporal data, in situ data availability, the desired format, degree of collaboration, etc.
- The NATO SFP – MDEO Website is live.
- MDEO Co-Director and Advisors published 14 articles and 2 editorials in peer-reviewed journals & delivered 17 presentations at scientific symposia and conferences, including 2 invited keynote addresses.
- The project received letters of support and was written about in 16 electronic news media articles.
- The NPD, Dr. Gilbert Rochon, PPD, Dr. Chaker El Amrani, one Co-Director, Dr. Gulay Altay were accompanied by a technical advisor Dr. Tarek El Ghazawi and financial consultant Mr. Glenn Dicjerson, CPA on a visit to NATO to discuss changes in the locale of the groundstations from Egypt to Morocco and the transition from Purdue to Tuskegee University.

Payments through NATO Funds: EUR 52,455

### Implementation of Results

Preliminary plans are being developed to transfer the operation of the Mediterranean Dialogue Earth Observatory to End-Users/Stakeholders on a sustainable basis. Such plans include training technicians, faculty and students at both Al Akhawayan University and Abdelmalek Essaadi University, and negotiating with Moroccan agencies to assume responsibility for managing the tracking station after completion of the NATO SFP grant.

NATO Consultant : N/A

Other Collaborating Institutions

- Dr. Mohammed Shokr, Environment Canada, Ottawa, Canada
- Dr Mohamed A. Mohamed, Senior GIS Scientist, United Nations Dept. of PeaceKeeping Operations (DPKO), MINURCAT, N'Djamena, Chad
- Dr. Tarek El Ghazawi, George Washington University, Washington DC, U.S.A.
- Dr. Subhas Sikdar, US Environmental Protection Agency (EPA), NRMRL, Cincinnati, OH, U.S.A.
- Dr. Virgil Buck Sharpton, Vice Chancellor for Research, University of Alaska, Fairbanks, Alaska, U.S.A.

Intellectual Property (IP) Rights : N/A

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SfP 982811

## **Microbiological safety of drinking water in Uzbekistan and Kyrgyz Republic**

Project Co-Directors: Mélinna Maux, IPL, France (NPD) (Tristan Simonart from 15/08/07 to 30/09/08)  
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Islam Usmanov, IWP, Academy of Sciences, Tashkent, Uzbekistan (Co-PD)

Approval Date: 20 June 2007  
Effective Starting Date: 15 August 2007  
Duration: 3 years, until August 2011  
NATO Budget: EUR 298,000

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Information about the SfP Project through Internet: [www.envsec.org](http://www.envsec.org)

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### Abstract of Research

Safe microbial drinking water supply of the population and safe of recreational waters are an acute priority in Central Asian Republics. The laboratories in Kyrgyzstan and Uzbekistan are currently applying analytical standards (GOST, SanPin) that were formerly developed in the Soviet and post-Soviet period or in the Russian Federation.

This project intends to set up the basic for reliable, traceable and harmonized microbiological water quality monitoring in this region, based on International ISO/WHO standards and requirements for quality assurance, under the supervision of the NPD (Pasteur Institute of Lille) and in direct coordination with reference national laboratories and Public Health authorities in Kyrgyzstan and Uzbekistan.

### Major Objectives

- Comparative study of Central Asia drinking water microbiological monitoring regulations with International ISO/WHO standards.
- Central laboratory training of reference laboratories on microbiological ISO standards for drinking water and ISO 17025 quality control accreditation requirements (location: NPD central lab, France).
- Transfer and implementation of these international standards in the 2 national reference laboratories (including consumables, equipments, standard documentation and organization of on site workshops).
- Evaluation of performance through proficiency testing (interlaboratory trial) between the 2 national reference laboratories, under the control of NPD.
- Final intercomparison study on natural (drinking water) samples, using in parallel national and ISO standards.

As a final direct output, an *International Conference on Microbial Safety of Drinking Water in Central Asia* will contribute to disseminate this NATO-SfP project's achievements, increasing in the same time awareness of Central Asian Public Health and Environmental Authorities, as well as water managers and scientific community.

### Overview of Achievements since the Start of the Project until 30 September 2011

- Literature on drinking water microbiology has been collected.
- Comparison of regulatory documents of Kyrgyzstan and Uzbekistan on microbiological analysis of drinking water.
- Training course at IPL France (organization, implementation, preparation of documents).
- Ordering and purchasing necessary for analysis laboratory equipment.
- Translation from English and French to Russian of IPL training documents on microbiological methods and schemes for analysis of water samples.
- Training of participants from Kyrgyz Republic in the National Institute of Standardisation and Metrology in Bishkek.
- Personnel training on EU directives and ISO requirements by trained project participants.
- Implementation of ISO methods to national laboratories.

Payments through NATO Funds: EUR 141,404

### Milestones for the Next Six Months

- Order, purchase, delivery and start-up of equipment (October 2011-February 2012).
- Purchase of ISO standards (November 2011-February 2012).
- Purchase of consumables and media (November 2011-February 2012).
- Preparation of inter-laboratory trials (March-April 2012).
- Inter-laboratory trials (April 2012).

### Implementation of Results

Activities taken to ensure implementation of the project results are the training of young scientists, including the cooperation of the scientists between Bishkek, Tashkent and Lille. The project has been highly collaborative between IPL, SPCPM and IWP; between SPCPM and Bishkek Center State sanitary-epidemiologic surveillance (End-users, Bishkek, Kyrgyz Republic) and Institute of Water Problems (IWP) and Republic Center of State sanitary-epidemiologic surveillance (End-user, Tashkent, Uzbekistan).

NATO Consultant : N/A

### Other Collaborating Institutions

End-user: Department of State Sanitary-Epidemiologic Surveillance, Bishkek, Kyrgyz Republic

Intellectual Property (IP) Rights : N/A

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Abbreviations: SfP: Science for Peace; NPD: NATO country Project Director; PPD: Partner country Project Director; NATO: North Atlantic Treaty Organization; IPL: Institute Pasteur in Lille; SPCPM: Scientific and Production Centre for Preventive Medicine; IWP: Institute of Water Problems; ISO: International Standardization Organization; WHO: World Health Organization.

SfP 982227

## **Water Resources Management of Agro-Ecosystems in the South Caucasus Transboundary Regions (Armenia, Azerbaijan, Georgia)**

Project Co-Directors: Prof. Gerrit Hoogenboom, University of Georgia, Griffin, Georgia, U.S.A. (NPD)  
Prof. Konstantine Bziava, Georgian State Agricultural University, Tbilisi, Georgia (PPD)  
Dr. Gurgen Yeghiazaryan, Armenian State Agrarian University, Yerevan, Armenia  
Dr. Rafiq Verdiyev, Association on International Hydrological Programme, Baku, Azerbaijan

Approval Date: 13 December 2006  
Effective Starting Date: 15 April 2007  
Duration: 4 years, until 31 December 2011  
NATO Budget: EUR 246,000

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Information about the SfP Project through Internet: <http://www.natochronicles.org/>

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### Abstract of Research

The transboundary region of the South Caucasus includes the countries of Armenia, Azerbaijan and Georgia. The population is represented by different religious and ethnic groups, with agriculture as their main source of income. As this region is located in arid and semiarid climatic zones, the available water resources, especially for irrigation, determine the level of agricultural production. Civil contention between the different ethnic and religious groups is due to not only the lack of adequate water resources for irrigation, but also the lack of efficient mechanisms to transport water to the end user and the absence of a timely water supply schedule to the water consumers. There is, therefore, a need for a radical change of this situation that can only be achieved by the introduction of state-of-the-art technologies for the management of agricultural crops, especially with respect to irrigation. One of these advanced techniques is drip irrigation, which has been widely applied in developed countries, especially in cases where water is a limiting resource. However, the introduction of state-of-the-art technologies requires applied research on the evaluation of these techniques for local conditions. This includes studies of the local soil-crop-atmosphere system, including detailed measurements of soil conditions using automated soil water measurement techniques, atmospheric conditions with automated weather stations and crop conditions through detailed sampling. It is expected that the improved irrigation systems will not only result in crop improvement, but also an increase in yield and farm income. This should lead to a revival of trade in the region, resulting in a reestablishment of an economic and communication network. These are the critical components of a long-term economic sustainability and social stability in the region, which will ultimately result in political security in the transboundary region of the three South Caucasus countries. The outcomes of the proposed project will promote intensification and sustainability of an agricultural production in irrigated agriculture that is one of main factors for the improvement of the social and economic living standards of the population and therefore security in the region.

### Major Objectives

The overall goal of this project is to enhance and improve the social and economic, demographic, ecological, and political security of the South Caucasus Transboundary region of Armenia, Azerbaijan and Georgia using modern scientific and state-of-the-art technological innovation that will improve the long-term sustainability of irrigated agricultural production systems. Specific objectives include:

- The development of a demonstration farm for evaluation of state-of-the-art irrigation water distribution techniques.
- The development of scientific techniques for estimating water use of agricultural crops based on local weather conditions and the hydrophysical characteristics.
- The creation of the South Caucasus Scientific Research, Information and Extension Center entitled "Water-Crop Security and Sustainability" for dissemination of the state-of-the-art irrigation scheduling technologies to stakeholders and end users in Georgia, Armenia and Azerbaijan.

## Overview of Achievements since the Start of the Project until 31 March 2011

- Initial start-up meeting in Tbilisi, Georgia, in April 2007 with all project participants.
- Development of demonstration plots in farmers' fields in Marneuli, Georgia, for the 2007, 2008, 2009 and 2010 experiments.
- Successful production of various agricultural crops, including tomato, bell pepper, eggplant, mini-corn, beet and onion.
- Drip irrigation resulted in yields that are 4 to 5 times higher than the yield of crops obtained under traditional irrigation.
- Drip irrigation resulted in water savings of up to 4 to 5 times compared to traditional irrigation.
- Participation by local farmers in the crop production system.
- Successful seminars to local farmers.
- Determination of the two study sites in Azerbaijan and Armenia.
- Preparation of information material for dissemination to farmers in Armenia and Azerbaijan.
- Determined the relationship between yield and optimum level of irrigation.
- Installation of drip irrigation demonstration field in Armenia.
- Comparison between traditional irrigation, drip irrigation and drip irrigation and plastic mulch in Georgia and between traditional irrigation and drip irrigation in Armenia during the 2008, 2009 and 2010 growing season.
- Successful installation of the automated weather stations in Georgia, Armenia and Azerbaijan.
- Successful installation of the soil moisture measurement system in the experimental plot in Georgia.
- Participation in a video production for a documentary on ecological sustainable agricultural systems: <http://www.natochronicles.org>.
- The project was featured on Euronews entitled "The Fruits of Peace". See the following link for further information ([www.euronews.net/2011/01/27/the-fruits-of-peace/](http://www.euronews.net/2011/01/27/the-fruits-of-peace/)).

Payments through NATO Funds: EUR 226, 266

## Milestones for the Next Months

- Evaluation of technique for estimation of potential evapotranspiration for irrigation scheduling.
- Analysis of weather and climate data collected at the three weather stations.
- Dissemination of results to stakeholders.
- Development of the science information centre.

## Implementation of Results

More than 200 people visited the demonstration site in Marneuli. Based on discussion with the supplier of the drip irrigation system, there has been an increased interest by local producers to purchase drip irrigation systems for their farm as well as in purchasing the improved varieties that were used in the experiment. Two seminars were held in Georgia for presentation of the results to local farmers. In addition, a poster and brochure was developed in Armenia to educate the farmers on the use of drip irrigation systems. A brochure on drip irrigation has also been developed in Azerbaijan.

NATO Consultant : N/A

## Other Collaborating Institutions

- Local farmers in the Marneuli region of Georgia
- Local farmers in Armenia and Azerbaijan.

Intellectual Property (IP) Rights : N/A

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SfP 983054

## Harmonization of Seismic Hazard Maps for the Western Balkan Countries BSHAP

Project Co-Directors: Prof. Sinan Akkar, METU, Ankara, Turkey (NPD)  
Prof. Branislav Glavatovic, MSO, Podgorica, Montenegro (PPD)  
Prof. Ismail Hoxta, Institute of Geosciences, Tirana, Albania (PPD)  
MS Vlado Kuk, Faculty of Sciences, Zagreb, Croatia (PPD)  
Amer Zoranic, Ministry of Civil Affairs, Sarajevo, Bosnia and Herzegovina (PPD)  
Prof. Mihail Garevski, IZIIS, Skopje, FYR Macedonia (PPD)  
MS Svetlana Kovacevic, Seismological Survey of Serbia, Belgrade, Serbia (PPD)

Approval Date: 20 July 2007  
Effective Starting Date: 1 October 2008  
Duration: 3.5 years, until October 2011  
NATO Budget: EUR 638,000

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Information about the SfP Project through Internet: [www.wbseismicmaps.org](http://www.wbseismicmaps.org)

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### Abstract of Research

Seismic hazard maps for the territory of participating Western Balkan countries will be realized. In the methodological approach unified earthquake catalogues, seismotectonic data and a consistent ground motion prediction model will be implemented to the probabilistic seismic hazard analysis. The output ground-motion parameter(s) describing the seismic hazard in the region will be provided that is consistent with the EUROCODE 8 and the design regulations of the countries involved in the project. All seismic input and output results will be presented through a consistent GIS database. Future researches in this field will be enhanced by new data collected by seismic instruments that will be deployed within this project realization.

### Major Objectives

- Establishing complete and consistent GIS database for the regional earthquake catalogue, seismotectonics and seismic hazard.
- Methodological improvement and harmonization of seismic hazard maps of the participating countries to surmount the existing artificial differences in the cross-border seismic hazard levels.
- Improvement of existing seismic monitoring networks through the deployment of strong- and weak-motion stations in the participating countries.
- Providing a consistent background for tailoring the seismic provisions of the [participating countries harmonized with EU standards (Eurocode 8).
- Establishing active collaboration between the participating countries, and training of future-promising young scientists in earthquake-hazard related topics.
- Publishing the major project findings that include the improved seismic hazard maps to share the outcomes with the seismological and engineering community.
- Encouraging the implementation of harmonized and upgraded seismic hazard maps by the concerned civil authority of each participating country to improve the seismic safety and seismic risk management.

### Overview of Achievements since the Start of the Project until 30 April 2011

- Upon the agreement on providing national earthquake catalogues the compiled regional catalog has been merged (including neighboring countries Greece, Bulgaria and Romania). The "F" version of earthquake catalogue with threshold magnitude 3.0 was presented. Unified earthquake catalogue was filtered from the dependant earthquake events (foreshocks and aftershocks), all events presented in local magnitude  $M_L$ .
- Partial attempts to remove the mistakes caused by processing of earthquake catalogue were done.
- Training of last version of Software OHAZ 6.1 realized during the Ig, Slovenia (Sponsored by ARSO) and Ohrid workshops.
- Upon of the International bidding call procurement of the instruments is done, majority of the instruments already installed.

- Memorandum on real-time data exchange was signed, as well as Memorandum on further development of OHAZ software source code. The selected number of new GMP formulas is implemented in OHAZ software, as well as other improvements.
- Results of various GMP models applicability to the region have been presented.
- The GIS software licenses are purchased; training in GIS is realized in coordination with project partner from Serbia. Compiled earthquake catalogues and the seismotectonic information implementation to the GIS software.
- The regional common input data file tested. First results in computing seismic hazard for the territories of BISHAP region presented and analyzed.

Payments through NATO Funds:            EUR 567,730.54

#### Milestones for the Next Six Months

- Identified catalogue data processing mistakes should be removed. Accordingly,  $M_L$  magnitude to be converted to  $M_W$ .
- Compiled seismotectonic information to be adjusted in respect to recompiled catalogue data. Seismotectonic model will be improved so to have better statistics of earthquakes inside tectonic regions.
- The selected ground-motion prediction equations are going to be tested in respect to local acceleration records.
- For the new input data final seismic hazard will be re-computed.
- The seismic hazard resulting map to be prepared as separate GIS layer.
- The instruments that experienced malfunction to be repaired. Final installation should take place.
- The current results and analysis will be published on regular basis on the project Web page and in papers. The data exchange will continue using dedicated FTP server.

#### Implementation of Results

The Civil Engineering Faculties/Departments of the regional universities as well as the concerned Ministries and Engineering Chambers are the major civil entities that will make use of the outcomes of this project to upgrade the national seismic provisions for their further adoption to EUROCODE 8 standards.

NATO Consultant : N/A

#### Other Collaborating Institutions

Environmental Agency of Republic of Slovenia, Ljubljana, Slovenia

#### Intellectual Property (IP) Rights

Participating institutions made an agreement to exchange the earthquake catalogue information for the scientific purposes of the Project.

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Abbreviations: ARSO: Environmental Agency of Republic of Slovenia ; B&H: Bosnia & Herzegovina ; IZIS: Institute for Earthquake Engineering And Engineering Seismology of University of Sts Cyril and Methodius, Skopje, Macedonia ; GMP: Ground motion prediction ; IGEO: Institute of Geosciences, Tirana, Albania ; METU: Middle East Technical University, Ankara, Turkey ; MSO: Montenegro Seismological Observatory

SfP 983284

## **Caucasus Seismic Emergency Response (CauSER)**

Project Co-Directors: Eileen Vergino, Livermore, U.S.A. (NDP)  
Zurab Javakhishvili, Tbilisi, Georgia (PPD)  
Avetis Arakelyan, Yerevan, Armenia  
Gurban Etirmishli, Baku, Azerbaijan  
Daniela Pantosti, Rome, Italy  
Niyazi Türkelli, Istanbul, Turkey  
Ioannis Kalogeras, Athens, Greece  
David McCormack, Ottawa, Canada

Approval Date: November 2008  
Effective Starting Date: July 2009  
Duration: 3 years, until July 2012  
NATO Budget: EUR 398,000

### Major Objectives

- Updating regional seismic and strong motion networks to improve regional coverage.
- Organize, equip and train multidisciplinary teams for comprehensive seismic observation.
- Organization of task-force teams for immediate response to strong earthquakes in the region and deployment at the epicentral area within 12-24 hours after an event occurs.
- Promoting cooperation and sharing of the resources and data.
- Stabilization in case of emergencies.
- Cross border cooperation.
- Promote development of next generation of technical experts.
- Prepare governments and population to respond to emergencies in the region.

### Overview of Achievements since the Start of the Project until 30 November 2011

**Task 1:** Equipping teams with seismographs, accelerographs and other equipment.

1.1 Selection of sites for permanent installations.

The sites for installation of seismographs have been selected in Georgia, Armenia and Azerbaijan.

1.2 Equipping teams with mobile seismographs for task-force operations and joint field experiments.

The new equipment have been tested. Teams were trained in maintenance and data processing. The new equipment was used during the field experiment in all countries of Southern Caucasus.

**Task 2:** Organization and training of multidisciplinary task-force groups and young scientists.

2.1 Organization of task-force groups in each country.

Training of the multidisciplinary task-force groups continued.

2.2 Training of young scientists.

Young scientists were trained in seismic data processing and analysis, installation and maintenance of seismic equipment, GPS measurements and data acquisition, GIS technologies.

2.3 Organization of international field investigations in the selected areas (in case of occurrence strong/moderate earthquakes) or organization of joint field experiment.

- According to the work plan 3 field investigations (summer schools) were organized in Javakheti region (South Georgia) on August 2-10, 2009 and August 22-30, 2010 and July 17-27, 2011.

- Field investigation were organized in epicentral area of M=6 earthquake September 7, 2009, M=5.7 earthquake January 17, 2011 and M=5.5 earthquake August 18, 2011 in Georgia. Aftershock sequence of moderate earthquake M=3.8 was studied in Armenia on June 2011. Landslide was studied in Baku, Azerbaijan in 2011. The new equipment purchased during the project was used in these field studies.

**Task 3:** Creation of a Communication Network for data acquisition and information exchange.

Improvement of communication systems were continued.

**Task 4:** Enrichment of the existing seismic and other databases.

The updating of data bases has been continued.

**Task 5:** Improvement of the regional attenuation model for the Southern Caucasus.

5.1 Analysis of existing strong motion data.

The all available strong motion data was collected and analyzed.

**Task 6:** Assessment of possible environmental and economic impacts due to damage or destruction of critical objects.

The sites and objects that can affect the environment in case of damage were selected for future detailed investigation.

**Task 7:** Make publically available data from new installation and field investigations for various scientific research in seismology and earthquake engineering.

7.1 Provide information available in a form useful to planners and public officials responsible for decision-making in case of a disaster.

Close collaboration has been established between the project participants and end users.

**Task 8:** Project coordination activities and publication of results.

8.1 Workshops and meetings to coordinate, share, and unify methodological approaches.

During the reported period a workshop was organized in Abastumani, Georgia.

Payments through NATO Funds: EUR 189,300.58

#### Milestones for the Next Six Months

- Purchasing of modern equipment (II stage): Strong motion sensors and broadband seismographs.
- Organization of the meeting in Tbilisi (March 2012).
- Preparation of scientific articles.

NATO Consultant : N/A

#### Other Collaborating Institutions

- Ministry of Education and Science of Georgia
- Emergency Management Department of the Ministry of Internal Affairs of Georgia
- Department of Urban and Natural Resources, Ministry of Urban Development of Armenia
- Ministry of Nature Protection of Armenia
- Armenian Rescue Service, Ministry of Emergency Management of Armenia
- Complex Hydrogeology and Engineering Geology Expedition; Baku, Azerbaijan
- State Town Planning and Architecture Committee of Azerbaijan; Baku, Azerbaijan

Intellectual Property (IP) Rights : N/A

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