



**ENRY2001**

# **ENVIRONMENTAL RECOVERY OF YUGOSLAVIA MONOGRAPH**

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**Edited by**

**Dragoljub P. Antić and Jasmina Lj. Vujić**



**VINČA Institute of Nuclear Sciences  
Belgrade, 2002**

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## PREFACE

*The purpose of this book (monograph) is to describe various environmental consequences of NATO bombing in Federal Republic of Yugoslavia from March 24 to June 10, 1999, and to give some recommendations for the environmental recovery of Yugoslavia. During the NATO bombing campaign in 1999, 78 industrial facilities and 45 energy installations were damaged or destroyed, releasing thousands of tons of various carcinogenic, mutagenic and toxic chemicals, including some persistent organic pollutants banned by the Stockholm convention for human use. Over 150,000 tons of oil and oil derivatives and 367,000 tons of kerosene were burned, more than 20,000 residential buildings were destroyed, and at least 31,000 rounds of thirty millimeter DU munitions were fired. G17 has estimated the damage to the infrastructure at over US\$30 billion.*

*The monograph is based on the papers presented at the First International Conference on Environmental Recovery of Yugoslavia, Belgrade, September 27 to 30, 2001. The conference included 142 presentations by 320 authors from 21 countries as well as three teleconference presentations from the U.S. Environmental Protection Agency (EPA). About 80 papers are included in the presented form, and some papers (about 30) are included in a modified (extended or completed) form. In order to have a more complete coverage in the book of important relevant topics, several contributions not presented at ENRY2001 are also included.*

*An assessment of environmental damage and prospects for environmental remediation are presented. The status of the region up to 1991 (including preexisting ecological characteristics, as well as social and economical development), and the changes between 1991 and 2001 that include the effects of external economic sanctions, civil wars, and the NATO bombing in 1999 are included in the assessments.*

*The ENRY2001 Activity Report and the Conference Conclusions and Recommendations are also included. These reports give a short overview of the various analyses presented at the ENRY2001 Conference, as well as conclusions and recommendations by several working groups. The general recommendations include the pressing need for: (a) establishment of a centralized environmental recovery and protection agency in FRY; (b) comprehensive assessment of environmental status in FRY; (c) risk assessment of contaminated sites and their ranking to establish clean-up priorities; and (d) immediate start of the "hot spots" remediation.*

*This book will be of use to researchers around the world, as well as to national and international agencies and organizations involved in assessment, remediation and prevention of environmental damage caused by wars and technological pollution.*

*Finally, we want to express our gratitude to colleagues, students and countless number of other volunteers who shared their enthusiasm, knowledge and talent with us in order to make this conference and this book possible.*

*Editors*

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## FIRST INTERNATIONAL CONFERENCE ON ENVIRONMENTAL RECOVERY OF YUGOSLAVIA (ENRY2001)

*Preface by  
Dr. Zorka B. Vukmirović, Research Professor,  
Belgrade, Yugoslavia*

At the outset of the Third Millennium, in addition to the global pollution issues, Yugoslavia is facing daunting challenges of having to deal with devastation to its environment and natural resources, ecological damage in vicinity of industrial plants especially due to 1999 NATO bombing and lowering of quality of life, including life shortening, due to a decade of debilitating international economic sanctions and isolation.

These challenges have been discussed by both governmental (republic, city and borough level) and non-governmental entities, business organizations, at scientific and professional meetings and by independent experts in their papers published domestically and internationally. It was felt by many that there was a need to include the Serbian Diaspora experts, especially those who have reached level of prominence in their respective professions, in a joint search for appropriate remedial actions and environmental recovery of Yugoslavia. In this spirit the First International Conference on Environmental Recovery of Yugoslavia (ENRY2001) represents a huge undertaking for the science, technology and the society in general. The organizers, professors in the USA, Jasmina Vujić and Tatjana Jevremović, with their bold initiative pleaded with objectivity and internationalism of science and availability of remarkable environmental accomplishments in order to assist in the cleanup of devastated environment not only in Yugoslavia but also in the whole region. Their initiative provided a direct avenue for presenting the problems before the international community by the affected businesses as well as by city and borough management.

Over 100 papers will be presented by domestic experts and about 40 by international including those from the Serbian Diaspora. The US Environmental Protection Agency (EPA) seminar needs to be singled out. It will present methodologies for identification and resolution of the problems at polluted sites employing state-of-the art cost effective remedies. At the same time, most encouragingly so, the Serbian youth will be provided with an opportunity to present their ideas and environmental conscience. One should also single out contributions regarding public health effects from NATO bombing and use of depleted uranium weaponry.

Originality and comprehensiveness of problem resolutions places this conference amongst the premier events in Yugoslavia. By virtue of accepting the sponsorship, the Serbian Orthodox Church, the governments of Federal Republic of Yugoslavia and the Republic of Serbia have immensely enhanced importance of the conference. This level of support obligates the participants to define resolutely the conclusions as well as to propose cost-effective solutions compatible with the international regulatory standards, recommendations, standards and conventions addressing fully the specifics of Yugoslavia. In addition to geophysics and geochemistry aspects, key factors of environmental recovery will be in the domain of strategic economic and social development that must be based on the principles of sustainability. In this respect, the conference needs to demonstrate coupling of creative forces and those individuals empowered to make political decisions in the field of environmental protection and advancement. A measure of success for implementation of conference conclusions will be analyzed at follow up conferences. However, the implementation solutions will be judged by mediation of the Agency for Environmental Recovery established during preparations for this first conference. In closing, one needs to emphasize that all activities from initiation to provision of financial resources and implementation of solutions represent a role model for joint efforts between the Serbian Diaspora and motherland in search of most complex solutions for recovery and advancement of our nation.

*Belgrade, September 2001*

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**FIRST INTERNATIONAL CONFERENCE ON  
ENVIRONMENTAL RECOVERY OF YUGOSLAVIA  
(ENRY2001)  
Belgrade, Yugoslavia, September 27 – 30, 2001**

## **ENRY2001 ACTIVITY REPORT**

**The First International Conference on Environmental Recovery of Yugoslavia - ENRY2001**, was held from 27-30 September 2001 in the Jugopetrol Business Center, Milentija Popovića 1, 11000 Belgrade.

The Conference was initiated by Prof. Dr. Jasmina Vujić from the University of California at Berkeley (California, USA) and Dr. Tatjana Jevremović from Purdue University (Lafayette, Indiana, USA), with an objective of initiating the overall environmental recovery of Yugoslavia through the presentation of existing problems in Yugoslavia, discussion of modern technologies for site remediation, and defining future directions for scientific, financial, legal and social aspects of restoring and protecting the environment.

A large number of domestic and foreign experts quickly joined this initiative because they realized the urgency of initiating tangible actions for the recovery of environmental situation in Yugoslavia. At the beginning of a Third Millennium, besides global environmental pollution problems, Yugoslavia is facing the problems of a seriously endangered environment and natural resources, significant environmental pollution around industrial complexes, and dramatic degradation of living conditions and public health because of a decade of devastating economic sanctions and, in particular, the NATO bombing in 1999.

Because these problems include some of the most complex issues and challenges for science, technology and society in general, the team of experts that was involved in organizing the conference included scientists and experts from universities, various institutes, industry, and health institutions in order to cover a wide range of issues such as technology, science, physical chemistry, geophysics, biology, agriculture, medicine, and psychology. As a result of the devoted work of this group of experts, the Conference was organized in less than eight months, despite very challenging political instability in Yugoslavia and in the entire world. It must be emphasized that the Serbian Unity Congress was involved in the Conference organization from the very beginning, and supported continuing

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efforts the as the first sponsor. From the large number of contributors, only the key personnel leading the efforts of different committees are listed here (the complete list can be found at [www.enry2001.org](http://www.enry2001.org)): Mr. Milan Gavrilović (EPS) and Prof. Dr. Jasmina Vujić were Co-Chairs of the Scientific Committee, Prof. Radisav Vidić (University of Pittsburgh, PA, USA) and Prof. Mihajlo Mesarović (CWR University, USA) were Co-Chairs of the International Program Committee, Mr. Jadranko Simić (Federal Ministry for Labor, Health and Social Policy) and Dr. Zorka Vukmirović (AAOM) were Co-Chairs of the Local Program Committee, Dr. Zora Žunić (Vinča Institute) and Dr. Tatjana Jevremović were Co-Chairs of the Organizing Committee. Executive Committee was comprised of Dr. Srba Jović (Aerospace Computing Inc., USA), Prof. Dragan Veselinović (PMF), Dr Tatjana Jevremović, Dr Vojin Joksimović (USA) and Prof. Jasmina Vujić (USA).

A number of domestic scientific and higher education institutions, industrial firms, domestic and foreign non-governmental organizations, and business and professional societies joined the efforts to organize this Conference. Sponsorship by the Serbian Orthodox Church and the Governments of the Federal Republic of Yugoslavia and Republic of Serbia significantly enhanced the visibility and importance of this Conference. Honorary sponsors of the Conference were the President of the FRY, Dr. Vojislav Koštunica, and the Serbian Orthodox Church Patriarch, His Holiness Pavle. Honorary Chair of the accompanying program "Youth and Environmental Protection" was HRH Princess Jelisaveta Karadjordjević.

The conference opening was on September 27, 2001 in the "Jugopetrol" Business Center, Milentija Popovića 1, New Belgrade. The opening ceremony was attended by more than 400 participants and numerous journalists. The welcoming address by the conference Co-Chairs, Prof. Dr. Jasmina Vujić and Dr. Tatjana Jevremović was followed by a message from the President of Yugoslavia, Dr. Vojislav Koštunica, that was delivered by Ms. Borislava Kruška, president of the City Assembly of Pančevo. Prof. Jasmina Vujić delivered a message from His Holiness, Patriarch Pavle. Dr. Zoran Djindjić, the Prime Minister of Serbia, greeted conference participants and delivered a firm commitment from the government of Serbia for environmental improvement and announced a formation of a new Ministry for Natural Resources and Environment as well as passage of new environmental legislation. HRH Princess Jelisaveta Karadjordjević stressed the need for enhancing knowledge and understanding of the environment and emphasized the role that youth can play in that process. Mr. Gaudenz Ruf, the Swiss Ambassador to Yugoslavia who represented the general conference sponsor, Swiss Agency for Development and Cooperation (SDC), greeted the conference participants. He discussed traditional Swiss participation in humanitarian activities around the world and emphasized that the Swiss government is ready to help Yugoslavia realize some of its environmental projects with financial assistance in 2001 in the amount of 50 million DEM. Dr. Tanja Knežević addressed the participants in front of federal institutions, while Prof. Dr. Dragan Domazet, Minister for Science, Technology and Development for the Serbian government, discussed a new program for scientific development of Serbia until 2010 that will insist on the development of new technologies that are in compliance with the needs for environmental protection and improvement. The opening ceremony included the address from Mr. Branislav Lečić, Minister for Culture in the Republic of Serbia, Prof. Dr. Marija Bogdanović, Rector of the University of Belgrade, and Dr. Krunoslav Subotić, Director of the Vinča Institute for Nuclear Sciences. One of the General Sponsors, The Serbian Unity Congress, was represented by Mr. Miroslav Djordjević who emphasized that this Conference points towards a real possibility of establishing the collaboration between our experts in the



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country and abroad on projects of utmost importance for the country. He urged the participants to implement the positive experiences from this Conference in future projects. Conference participants were greeted by Slavica Lazić-Vuksanović from the Federal Institute for Maintenance and Development of Inland Waterways and Mirjana Božidarević, President of the Stari Grad Municipal Assembly. The Conference organizers also received a letter of support from HRH Crown Prince Alexander of Yugoslavia.

The conference included 142 presentations from about 320 authors from 21 countries (presentations were organized in about 40 sessions which were held in two halls), as well as three teleconference presentations from the U.S. Environmental Protection Agency (EPA). Over 200 experts from all fields, including about 40 from abroad (about 10 were of Serbian origin), participated in the Conference. More details about the Conference, including the entire program, can be found at <http://www.enry2001.org>.

One group of Conference presentations focused on the consequences from the destruction of industrial complexes resulting from NATO bombing, damage to the environment throughout the period of economic sanctions, specifics of the air, water, and soil degradation, damages to the biodiversity, food quality, medical and psycho-social consequences for the population, etc. The second part of the Conference was devoted to the technologies and approaches for the remediation of the environment, issues in organizing such activities, and required activities for future protection of the environment. The third group of presentations were specific proposals for remediation and recovery of industrial complexes and other “hot spots”. We will emphasize only several interesting sessions: Environmental Impact of War in Yugoslavia, Status of Environment in Yugoslavia Prior to the NATO Air Strikes, Environmental Consequences Caused by Destruction of Industrial Facilities, Degradation of Ground Water Environment, Toxic and Heavy Metal Contamination, Biomedical Effects, Psychosomatic and Social Consequences, Ground Water and Soil Remediation, Environmental Recovery and Organizations and Projects, and Experiences and Potential in Nuclear and Alternative Energy Sources.

Special attention should be given to three seminars by the U.S. EPA that were organized by Dr. Walter Kovalick, Director of the Technology Innovations Office, together with Drs. Jasmina Vujić and Radisav Vidić. These seminars discussed latest methodologies for identification and ranking of contaminated sites and application of the latest and most economic technologies for their remediation. The U.S. EPA also generously donated numerous copies of various reports and CDs that were distributed among Conference participants. All three seminars are available for downloading in PowerPoint format at <http://clu-in.org/enry/>. The two seminars organized by Prof. Dr. Marija Todorovic entitled “Renewable Energy and Material Resources, Environmental Technologies, Ethics and Nonpathological Development for Sustainability” are also worth emphasizing here.

Special achievement of the Conference comes from a significant number of presentations that focused on the possible health impact of depleted uranium ammunition used during the NATO bombing campaign in 1999. A total of 19 presentations from authors coming from 9 different countries were given in 4 consecutive sessions regarding: (a) the use of DU weaponry, and (b) measurement techniques and sampling methodology. Together with domestic experts, 11 prominent world experts from 8 institutes for the first time offered their independent measurements and assessment of the situation in Bosnia, Kosovo and southern Serbia. Lively discussion followed in the Discussion Panel. Conclusions from this Panel are included in the general conclusions from this Conference. Depleted uranium sessions were organized by Dr. Zora Žunić (Vinča Institute) in collaboration with Dr. Jasmina Vujić. The DU papers from the Conference will be also published in a

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special issue of *Archive of Oncology*, a scientific journal published by the Institute for Oncology from Sremska Kamenica, Yugoslavia. Experts from abroad also visited the southern Serbian region around Vranje and locations of Bratoselce and Pljačkovica, where depleted uranium ammunition was used.

A number of activities and manifestations accompanied this Conference. The "Youth and Environmental Protection" program was organized under the patronage of HRH Princess Jelisaveta Karadjordjevic and in collaboration with the Children's Friends Society from Belgrade. This program included a competition among elementary and high school students in literary and artistic works focused on the environment as well as the organization of various environmental and ecological projects. Selected works were displayed at the Conference site while most of the paintings and other artistic works were auctioned and monetary contributions were given to humanitarian projects. The best paintings were reproduced on greeting cards that were also sold during the Conference.

The awards in the "Youth and Environmental Protection" program were given by HRH Princess Jelisaveta Karadjordjevic: 18 awards for paintings, 3 awards for literary works, 6 awards for projects and 5 awards for teachers. The first place was awarded to the project "Water from Lok – Our Treasure" that was achieved through collaboration between two elementary schools: "Svetozar Miletić" from Lok and "Isidora Sekulić" from Šajkaš. The students from these two schools received outstanding reception by Conference participants during their presentation on Friday, September 28, 2001. A short documentary about their region was followed by the presentations of the main ideas of the project including possible implementation. The model of the ecological park that is to be built around a spring of medicinal water was on display throughout the conference. Second and third place in the category of elementary schools were awarded to "St. Sava" school from Rumenka and "Miloš Crnjanski" school from Belgrade, respectively. The first place in the high school group was awarded to Aleksandar Pavić, student of the "Vera Blagojević" high school from Šabac for his paper on "Impact of Šabac Industry on the Environmental Condition of the Sava River". His paper will be published in the Conference proceedings and he will represent Yugoslavia at the ecological conference in Canada next year. Second and third place were awarded to the Ecological group from the "Vuk Karadžić" high school in Loznica.

Several excellent documentaries were shown during the Conference: "Natural Heritage Under the Bombs" produced by Institute for Protection of Nature of Serbia; "Pančevo Spring 99" – producer Cine Pro from Pančevo, author Miloš Nikolić, photography Bogdan Petrov, music Dragan Nikolić; "Niš in the Hell of War" – produced by NTV, RTV-5 and RTV "Belle Amie, author and director Mr Novica Randjelović; "Gatherer of the Herbs" (author Slobodan Popović) and "Survival of Degenerics" produced by the ZOOA Wildlife Society in collaboration with ECO-Studio from Belgrade.

The owner of "Jefimija" Gallery Slavica Mladenović decorated the Conference hall with hand-made authentic Serbian rugs and table covers, and invited all participants to the "Jefimija" Gallery "exhibition at the Russian House on September 27<sup>th</sup>. Association "Hi Neighbor" displayed and sold selected needlepoint and other hand-made craft by refugees as a part of the Program for Social Integration and Psychological Support. Panel exhibition by several cities presented their local ecological problems and suggestions for possible solutions. The Conference was greeted by the Hot-Air Balloon Competition participants on September 27<sup>th</sup> – the Aerotrade balloon was carrying the ENRY2001 banner. All participants were invited to a cocktail party at the Belgrade City Hall by the Mayor of Belgrade Radmila Hrustanović (on September 28<sup>th</sup>), where a beautiful musical program was prepared by the Academic Choir "Španac".

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Although the participation of a larger number of international organizations and companies was expected by the organizers of the Conference, an unstable political situation in Yugoslavia and abroad did not allow it. However, having in mind that this is the first conference in a series of similar events, the organizers hope to bring in a large international participation in the future.

The Conference location was moved from “Sava Centar” to the “Jugopetrol” Business Center, after a generous offer by Jugopetrol to become a general sponsor of the Conference. The following sponsors were responsible for the success of the Conference:

- (a) **General Sponsors** - Swiss Agency for Development and Cooperation (SDC), UNESCO, NIS – Jugopetrol Beograd, Plovput Beograd, and Serbian Unity Congress, USA;
- (b) **Main Sponsors** - Ministry of Science, Technology and Development, Serbia, Yu; Federal Ministry of Labour, Health and Social Care, Yu; Ministry of Health and Social Policy – Serbia, Yu; Ekoce, Real Estate Agency - Belgrade, Yu; Ericsson, Belgrade, Yu; Hydrometeorological Institute-Serbia, Yu; Jaroslav Černi Institute, Belgrade, Yu; Electric Power Industry of Serbia, Yu; Individuals, USA; Publicum, Yu; Renaissance Travel, USA; Stari Grad Municipality, Belgrade, Yu; Studenica Foundation, USA; The Hercegovina Charity Fund, USA; The Serbian Benevolent Society, USA; Uno Martin, Sabac, Yu;
- (c) **Sponsors** - Aerotrade, Belgrade, Yu; Application, Belgrade, Yu; GEMAX, Belgrade, Yu; Individuals, Japan; Jefimija Gallery, Belgrade, Yu; NIS – Oil Refinery, Belgrade, Yu; Revision Agency, Belgrade, Yu; Simpo Company, Water Factory Rosa, Vranje, Yu.

The preliminary conclusions were formulated and accepted during the last day of the Conference. Several working groups were formed to work on the final conclusions. The overall agreement was that the Conference was very successful in the presentation and analysis of the environmental problems caused by the NATO bombing and a long period of economical sanctions, as well as in outlining the ways to remediate the situation. These are some important preliminary conclusions and recommendations:

- 1) This is just a beginning of the work on ecological recovery of Yugoslavia, and more activities are being planned for the future;
- 2) There is a large potential in experts of all profiles in the country, as well as abroad among the international experts of our origin, that could work together to initiate collaboration with international scientific institutions, companies and financial organizations
- 3) This collaboration should be initiated by our experts through various proposals that could be a starting point for a broader collaborations with international institutions and organizations;
- 4) It is necessary to establish a pool of young researchers and experts which will be educated through this collaboration to carry on the implementation of modern methodologies for environmental protection and recovery under the specific conditions in Yugoslavia;

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- 5) The full papers (there 142 papers by 320 authors from 21 countries) will be published in the Conference Proceeding in 3-6 months.
  - 6) A new ENRY Organization has been established to carry on with the realisation of the Conference conclusions and recommendations. The name of this Organization should be changed to ENPRY – Environmental Protection and Recovery of Yugoslavia).

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**FIRST INTERNATIONAL CONFERENCE ON  
ENVIRONMENTAL RECOVERY OF YUGOSLAVIA  
(ENRY2001)  
Belgrade, Yugoslavia, September 27 – 30, 2001**

## **ENRY2001 CONCLUSIONS AND RECOMMENDATIONS**

### **INTRODUCTION**

At the beginning of the Third Millennium, in addition to a continuing economical downturn, financial crisis, and political instability, Yugoslavia is facing daunting challenges of having to deal with devastation to its environment and natural resources, ecological damage in vicinity of industrial plants especially due to 1999 NATO bombing, and lowering of quality of life, including life shortening, due to a decade of debilitating international economic sanctions and isolation.

During the bombing, 78 industrial facilities were damaged or destroyed, releasing thousands of tons of various chemicals, over 100 000 tons of oil and oil derivatives were burned, more than 20 000 buildings were destroyed, and at least 31000 rounds of thirty millimeter DU munitions were fired.

Any assessment of environmental damage and prospects for environmental remediation must be performed taking into account: (a) the status of the region up to 1991 (including preexisting ecological characteristics, as well as social and economical development), and (b) the changes between 1991 and 2001 that include the effects of external economic sanctions, civil wars, and the NATO bombing in 1999. Regarding medium and long-term health effects, epidemiological study must be conducted to collect data and assess health risk, psychosomatic and social consequences.

This report will give a short overview of the various analyses presented at the ENRY2001 Conference, as well as conclusions and recommendations by several working group.

### **AIR, SOIL, SURFACE AND GROUND WATER POLLUTION**

Well documented consequences of attacks on chemical plants, most particularly the petrochemical and nitrate fertiliser plants in Pančevo, have included dense clouds of

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toxic chemicals including vinyl chloride monomer, ethylene dichloride, chlorine, phosgene and ammonia. Bombing of electricity transformer stations has resulted in leaks of pyralen and other compounds. The health and environmental consequences of such emissions have yet to be evaluated, but all these compounds are extremely toxic. Several are environmentally persistent and accumulate in the food chain; several are carcinogenic and mutagenic. It is certain that at least some effects extend beyond Yugoslavia's borders. Atmospheric dioxins recorded in Skopje (Macedonia), downwind of Pancevo immediately following the NATO bombardment, are said to have reached seven times the internationally agreed 'safe' levels. Dioxins and other airborne toxins resulting from NATO bombing have also been recorded in Poland, Hungary and Greece. Again, further systematic monitoring is required to see whether these emissions, severe but localised in time and space, will lead to significant long-term effects.

Air pollution prior to 1990 was mainly concentrated in urban areas: thermal power stations, industrial processes, factories, domestic heating, wildfires and automobile exhausts. Inefficient energy utilisation and low technical efficiency of manufacturing and other plant have made the situation worse, and have offset the otherwise positive consequences (for air quality) of economic decline. A major problem in FRY (as elsewhere) is incompatibility in data sets. Air pollution can threaten the health of people, trees, lakes, crops, and animals, as well as damage the ozone layer and buildings. Air pollution also can cause haze, reducing visibility in national parks and wilderness areas.

One of the key indicators of environmental conditions in a given region can be obtained by examining environmental parameters of both surface and ground waters in that region. This is quite evident from a number of presentations given at this conference that focused on water quality parameters throughout Yugoslavia.

Even during NATO air campaign in Yugoslavia and certainly in the months following the destruction of major industrial and commercial facilities, a number of monitoring programs have been initiated to assess the extent of environmental damage resulting from this destruction. These programs focused on the several "hot spots" around refineries, fuel storage facilities, petrochemical industry, and chemical and industrial plants, where the destruction of these facilities lead to significant releases of toxic and hazardous chemicals into the surrounding environment. Most prominent ones include Pančevo (oil refinery and chemical complex), Novi Sad (oil refinery), Smederevo (fuel storage), Valjevo (industrial complex), Kragujevac (industrial complex), and Bor (mining complex). Monitoring efforts were primarily focused on heavy metals, PAH, PCB, BTEX and chlorinated solvents. In general, the initial sampling campaign revealed low levels of organic compounds in deeper groundwater aquifers. However, significant temporal variability in the concentration of these substances suggest possible contaminant plume movement in the subsurface and requires long-term comprehensive monitoring program to ensure environmental quality of major drinking water sources. This is particularly important having in mind well-documented significant contamination of soil and shallow groundwater aquifers in these areas and high probability that some of these contaminants will eventually reach deeper water supply aquifers.

A great focus has already been placed on source reduction in both Pančevo and Novi Sad in order to prevent contamination of drinking water supplies for these cities. It is clear that further remediation measures will have to be taken at both locations. In addition, serious heavy metal contamination of soils around these "hot-spots" and elevated heavy metal levels in groundwater indicate that these locations will represent long-term environmental problem. Well-documented degradation of surface water quality in the vicinity

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of destroyed installations, most notably of Danube in the region of Novi Sad and Pančevo, requires immediate and wide-ranging attention to this part of the country. It is also clear that enormous quantities of highly-contaminated sediments deposited during the last 30 years in the Iron Gate Reservoir represent one of the most challenging environmental problems that will require unprecedented efforts to resolve.

Immediate attention to these problems is needed to avoid further environmental degradation and ensure future health and safety of the citizens of Yugoslavia. A centralized agency that would coordinate monitoring efforts, collect and analyze data in order to perform risk assessment, establish trends, and prioritize environmental activities, and coordinate environmental improvement efforts is sorely lacking. It is also an imperative to establish a rigorous quality assurance/quality control program for environmental monitoring to ensure validity of the data collected in these monitoring campaigns. This is especially important having in mind that long term monitoring program will be required to assess the risk of environmental pollution and to document the effectiveness of remedial measures that will be undertaken. A number of innovative technologies, both biological and physical/chemical, for soil and groundwater remediation have been discussed at the conference. It appears that most of the problems related to chlorinated solvents, petroleum hydrocarbons and heavy metals may be appropriately addressed using inexpensive approaches like permeable reactive barriers, accelerated bioattenuation and phytoremediation.

Besides these alarming problems caused by the bombing campaign in 1999, past decades of neglect have resulted in serious shortfalls in environmental conditions throughout the country. Municipal and industrial wastewater collection and treatment systems were considered a burden to the national economy and their absence resulted in significant pollution of both surface and ground waters with various inorganic and organic contaminants. On the other hand, most of the drinking water plants lack necessary treatment steps to deal with precisely these contaminants. A serious investment in both of these areas should be one of the priorities for both local and state governments.

## **DEPLETED URANIUM ISSUES**

A total of 19 papers contributed by authors from 9 different countries were presented in 4 consecutive sessions. The papers could be grouped into those dealing with: (a) use of DU weaponry; and (b) measurement techniques and sampling methodology. Together with domestic experts, 11 prominent world experts from 8 institutes for the first time offered results of their research. Subsequently, a lively panel discussion took place.

### ***DU Paper Overview***

General Zarić, chief of Nuclear-Biological-Chemical Defense Department, presented invaluable VJ (Vojska Jugoslavije, Yugoslav Army) insights into the NATO use of DU weaponry during the 1999 Kosovo war. VJ anticipated that American A10 tank buster would use DU weaponry and acted to protect its troops. Detailed map with locations of DU ordinance existed the day VJ withdrew from Kosovo on June the 10th. NATO provided a list of 112 locations a year later at the request of the UN Secretary General. In November 2000, UNEP conducted a field mission and took samples from 12% of NATO sites. Zarić presented a map of Kosovo with the NATO, VJ and UNEP sites showing significant differences leading to a conclusion that the true story is not fully known yet until the

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discrepancies are resolved. The NATO map also excluded locations from four sites in Southern Serbia and one from Montenegro. The sites in Southern Serbia are fenced off while the site in Montenegro was cleaned up. The VJ conducted a medical examination of 1800 soldiers who were potentially at risk. From this a smaller group was formed for additional examinations and follow-up. Malignant diseases have been observed thus far but cannot be conclusively linked to DU exposure. Joksimovich, consultant from the U.S., presented results of his literature research including the DU use in three wars: Persian Gulf, Bosnia and Kosovo. He concluded that since the underlying causes of the so-called Gulf and Balkan syndromes have not been found over a decade, the DU must continue to be a prime suspect. Hence, it is prudent to call for a moratorium which is what general Zarić called for as well. Joksimovich also felt that DU use in the Kosovo war reckless in the extreme. Ajdačić, of the Vinča Institute, challenged NATO credibility by pointing out additional locations in Albania and Macedonia and claimed firing of 43,300 rounds rather than NATO's official figure of 31,000. Stegnar, from Slovenian Jožef Štefan Institute, summarized the IAEA mission findings including no link to leukemia. McLaughlin, University College Dublin, analyzed a DU penetrator recovered from a target site in Southern Serbia which was found to contain minute traces of plutonium (Pu). He concluded that the radiation dose from the Pu contamination of the DU was much smaller than that due to the uranium isotopes themselves and therefore concern over the Pu could be reasonably dismissed. This conclusion was also corroborated by three other Labs in Europe. There was a unanimity amongst the authors that possible health risks arise from inhalation of DU aerosol or from ingestion via the food chain. In terms of health effects uranium in common with other heavy metals like lead is primarily chemically toxic rather than radio-toxic. Therefore if high intakes of DU occur the chemical toxicity via the food chain may result in damage to organs such as the kidney in particular. .

Priest, Middlesex University, UK, with funding from BBC Scotland collected 25 urine samples from members of the public in Bratunac (Bosnia) and Djakovica and Klina in Kosovo. All subjects measured excreted DU although levels were mostly lower than those of natural uranium. The presence of DU in urine of a 1-year old child indicate the exposure is continuing. Mietelski, Institute of Nuclear Physics, Krakow, Poland, analyzed an aluminum jacket of DU bullet found in Kosovo using gamma and alpha spectroscopy. The gamma spectroscopy turned out to be more useful for the studies of uranium isotopic ratio. Anagnostakis, National Technical University Athens, discussed measurement options for identifying DU in the presence of natural uranium. Orlić, Vinča Institute, summarized uranium content measurements from bomb craters. With exception of the Cape Arza location in Montenegro, the concentrations were comparable to natural uranium levels thus corroborating general Zarić findings that the DU was not used by NATO in Tomahawk Cruise missiles bombings of Serbia. Pavlović, Vinča Institute, reported on contamination of the Adriatic Sea and its shore near Cape Arza in Montenegro. 2000 divers active in the area represent the most affected population group. Navratil, Clemson University in South Carolina, presented advances in treatment methods for uranium contaminated water and soil at U.S. Department of Energy sites.

### ***DU Panel Discussion***

Mieteleski, Waligorski, Priest, McLaughlin, Stegnar, Ajdačić and Joksimovich were the panelists. Stegnar acted as the moderator. Many participants in the audience provided contributions in addition to the panelists. Several panelists made a point that only



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scientific data and approaches should be taken into account as opposed to the political ones. Two approaches were discussed. One would connect the DU issue with new cases of cancer, while the second would focus on detection of possible observable health effects. The necessity of measuring, quantifying and assessing the actual situation in targeted areas was emphasized. The importance of standardizing methodology and sampling protocols in the fieldwork was also stressed. Quality assurance procedures must be established. Critical groups of potentially exposed people should be identified first. It was noted that studies dealing with health consequences of the Chernobyl accident demonstrated significant health detriment in the affected population attributable to the psychological stress resulting in alcoholism, suicide and other psychosocial problems. Similar types of stresses have been observed in the Balkans. Some panelists were leaning towards equating the risk of DU exposure to that of natural uranium plus stress while the others quoting the Gulf War cases felt that the DU exposure might pose additional risks.

### ***DU Concluding Remarks***

Public reaction to any kind of risk situation is strongly related to the perception of that particular risk. Among the others factors, perception of risk is also dependent on the controllability of risk and the uncertainties related to it. After the NATO actions in FRY, the population was additionally anxious concerning the lack of accurate data about the targets bombarded with the DU, possible health effects and overall risk assessment. Thus, discrepancies between the NATO and VJ data regarding use of DU ordnance in Kosovo needs to be resolved as soon as possible. UNEP could be involved. An agreed upon data base (how much DU was used and where) should be established which would include all affected sites in Bosnia, FRY (particularly in Kosovo) and Macedonia. Existence of this data base would have multiple benefits including reduction in public anxiety. It would enable both the international community and the Serbian authorities to plan and fund relevant epidemiological data studies.

An international cooperation under the auspices of WHO and/or other relevant international organizations should be established to plan and fund a scientific study of the health and environmental risks of long and medium term exposure (radiological and chemical-toxic) to DU on population. The existing epidemiological data obtained in adult uranium worker studies may not, for a number of reasons, be directly applicable to the general population consisting as it does young children and people with existing health problems. The results of this scientific study would provide the authorities with an objective basis for dealing with public perception of the DU contamination and thus would yield to a reduction in psychological stress.

The sites in Southern Serbia, currently fenced off, need to be cleaned up in due course. The same is true for the sites in Kosovo.

### **FOOD SAFETY**

In FRY legal framework for food safety was based on internationally recognized scientific research. Despite all well known political events, sanctions and NATO interventions, food safety control system sustained, probably due to the widely accepted importance and recognized public health impact of this issue. In 1989 due to the initiative of Federal Institute of Public Health, the annual food safety-monitoring program was

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established: 22 food items are tested on the quality standards parameters as well as on food safety including microbiological and chemical parameters.

Very few studies in FRY have provided data of complete bio-monitoring of the certain pollutants, and thus no proper and accurate data on contaminants consumption could be obtained. In order to prevent entering the contaminants to the food chain, new recommendations from WHO, FAO and EU suggest implementation of integrative approach to food safety known as "from farm to table". This new system of integrative control should provide both safer food for our population, and adequate products for export, thus helping sustainable development of the agriculture.

### **HUMAN HEALTH (BIOMEDICAL EFFECTS)**

Prolonged environmental degradation and reduction in standard of living during the 10-year period of economic sanctions and isolation, culminating in the 1999 NATO intervention, had imposed a substantial health risk for the entire population of Yugoslavia, and in particular those living in the regions identified as "hot spots". During the bombing, 78 industrial facilities were damaged releasing thousands of tons of various chemicals, over 100 000 tons of oil and oil derivatives were burned, at least 31000 rounds of thirty millimeter DU munitions were fired, and more than 20 000 houses were destroyed. For the first time in the history so many different pollutants in large concentrations (up to 1000 times permissible) had been released in the dense populated areas. Most of them are well known toxic substances (heavy metals, ammonium, sulfur dioxide, nitrogen oxide), that also could have mutagenic, teratogenic and oncogenic properties (ethylene dichloride, vinyl chloride, PCB's, etc.)

Papers presented at this conference have proposed models for malignant disease risk assessment. The projection of the incidence rate up to the year 2020 and the regional distribution had been calculated based on the 30-year descriptive and analytical epidemiological studies. According to that, sharp increase in cancer rate could be expected particularly in some population groups. Since the latency period for most malignant diseases is over 5 years, long term follow up studies are required. Meanwhile, analytical procedures (biomarkers and gene markers) based on molecular genetics had been proposed as a part of the process of monitoring and preventing serious health consequences.

Prof. Vukašin Radmilović, Kragujevac University School of Medicine, employed the International Association for Research of Cancer (IARC) classification of ten most frequent carcinogens in humans: benzo(a)pyrene, vinylchloride, benzene, PCB, dioxins/furans, arsenic, cadmium, nickel, chromium and DU. Using modest publicly available measurements during NATO bombing for concentrations of these carcinogens, he expressed these measured concentrations in units of carcinogenic factor contamination (CFC). CFC varied between 1 and 4 million for benzo(a)pyrene illustrating a range of substantial risk increases depending on carcinogen. The bottom line is recommendation for a comprehensive study of carcinogens with assistance from a country with experience in analyzing health consequences from industrial accidents and a call for urgent remediation measures.

Professor Miodrag Djordjević, Clinic Center Bežanijska Kosa Belgrade, presented a projection of malignant diseases in Yugoslavia with specific regard to Belgrade up to the year of 2000. Compared to 1997 the number of death would double (from 20,000 to 40,000). The impact of NATO bombing is unaccounted for. A new algorithm is needed to account for the impact of NATO bombing as well to take into account cancer prevention and screening.

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Retrospective study that was done in pre term newborn (1996 – 2001) had revealed the incidence rate of congenital malformations to be stabile, ranging from 12.7 to 19.2 %. Some other small-scale studies had pointed out that psychosomatic and social consequences could be of utmost importance in overall health impairment.

Polarized views of different interest groups on Gulf War and newly proposed Balkan Syndrome etiology and consequences, maintain long term controversy mainly due to the lack of meaningful and objective interdisciplinary research. Despite dismissing some of the worst claims on the dangers of DU and other pollutants, denial does not eliminate fact that veterans of Gulf and Balkan War are being sick and dying.

The considerable scientific uncertainties concerning health impacts of seriously degraded environment in Yugoslavia are even more important for civilians living in post-conflict environment. This high-risk population should be under long term surveillance and if necessary medical care for all of them should be provided. Both prevention and management actions should be evidence based.

A centralized government agency proposed to collect and analyze data in order to perform risk assessment should incorporate Rapid System of Notification of Environment borne diseases (like one that we have for Infectious Diseases). It should be connected with both district public health authorities and inspections capable for implementing immediate measures and sanctions in order to prevent health hazards.

## CONCLUSIONS

Continuing economical downturn, financial crisis, political instability, destruction caused by war, are proving to be highly destructive to the environment and may have extremely negative long term consequences on environment and population. Although it is difficult to envision that any substantial progress on environmental recovery in FR Yugoslavia will be made until political, economic, financial and social stability is restored, environmental remediation and protection of nature and natural resources must be included in any economical plan for recovery of country.

These are main conclusions and recommendations:

### (A) ESTABLISHMENT OF A CENTRALIZED ENVIRONMENTAL RECOVERY AND PROTECTION AGENCY

This government agency should:

1. Establish long-term national environmental policy,
2. Strengthen environmental institutions and enforce environmental laws and regulations,
3. Modify and harmonize national environmental regulation to conform to the European Union regulation,
4. Coordinate monitoring efforts,
5. Collect and analyze data in order to perform risk assessment, establish trends, and prioritize environmental activities,
6. Coordinate environmental remediation and improvement efforts,
7. Propose long-term plans in environmental restoration and protection,
8. Establish information and educational resources.

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## (B) COMPREHENSIVE ASSESSMENT OF ENVIRONMENTAL STATUS IN FR YUGOSLAVIA

The devastation of the environment in Yugoslavia has been built up over a period of many years. This clearly suggests that the starting point for any comprehensive assessment of the environmental status of FR Yugoslavia must precede NATO bombing. This initiative recommends that the whole observation interval be divided into four segments with the following principal activities:

1. 1990 as the reference starting point or ground "zero state." All available data prior to dissolution of Yugoslavia should be taken into account including assessments of international experts using state-of-the-art methodologies.
2. June 1992 - March 1999 as the interval of depleting environmental resources due to imposition of the UN economic sanctions on May 30 (UN Resolution #757). All available measurements of environmental quality indicators as well as modeling of pollutant depositions should be taken into account.
3. 1999 NATO Air Campaign, March 24 - June 10, regional consequences including those in FYROM, North Greece, Bulgaria, Romania and Hungary. All available environmental quality indicators should be taken into account. Uncontrolled pollutant releases into the atmosphere should be assessed taking into account material balances associated with burning and evaporation of crude oil and its derivatives, releases of toxic chemicals from chemical/ petrochemical plants and fuel storage facilities as well as release of pyralene from damage to transformers. Due emphasis will be placed on heavy metals (Hg, As, Cd, Ni, Be, Pb, Cr, Cu, Zn, DU) and persistent organic pollutants (POPs) with the following representatives: PAHs, PCBs and dioxins/furans. Impact assessments should be provided using local scale such as for the above mentioned hot spots, regional scale especially for environmentally protected areas and the agricultural regions for food chain products.
4. June 10, 1999 to date. Basis should be integrated environmental monitoring of all above listed pollutants in all environmental media, i.e. air, water and soil, with emphasis on the food chain. Number of monitoring stations and frequency of sampling should be commensurate with the expected pollution levels.

In addition to most reputable institutions in Yugoslavia, other reputable laboratories in the region need to participate. Intercomparisons of measurement techniques between the participating labs should be performed in order to achieve international standards. The initiative needs include appropriate laboratory instruments, field experiment equipment and various chemicals. Obtained data should be analysed from the standpoint of all relevant environmental parameters, i.e. meteorological, hydrological, geochemical, topographical, etc. Yugoslav multidisciplinary experts would constitute bulk of the project personnel supplemented with regional experts from Greece, Bulgaria, FYROM, Romania and Hungary. The Serbian diaspora experts will have a leading role in a joint search for appropriate remedial actions and environmental recovery of Yugoslavia.

## (C) RISK ASSESSMENT OF CONTAMINATED SITES AND THEIR RANKING TO SET CLEAN-UP PRIORITIES

Hazardous site ranking promotes the effective use of limited funding resources and expertise. First and foremost FRY needs to very carefully do an expert analysis of risk of all

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those contaminants that were released during the bombing. The politics and rhetoric needs to be taken out the expert discussions, otherwise, FRY will waste its precious money remediating environments that pose little or no potential health or environmental risk. However, it must quickly identify those sites that present immediate and threats to human health and the environment. The hazardous site ranking should include:

1. Characterization of pollutants: identification, source, estimation of quantities, evaluation of chemical properties (mobility, persistence, toxicity, bioconcentration).
2. Routes of migration: groundwater, surface water, air, soil ingestion.
3. Identification of the risks: is there a human health risk (immediate, long-term), is the environment threatened, is the socio-economical stability of the area threatened, is the risk acceptable, what is the uncertainty.
4. Inclusion of other factors that might influence site ranking: cost of cleanup, political factors, public opinion, potential for reuse.

Priority must also be given to preparation of a feasibility study for clean-up activities in areas identified in the Federal Republic Report – The Consequences of NATO Bombing for the Environment in FR Yugoslavia, prepared in February 2000 by the former Federal Ministry for Development, Science and Environment.

Assessment of environmental pollution must be made on other sites with fuel storage facilities destroyed during the NATO bombing like fuel storage facilities near Smederevo, Sombor, Novi Sad, Priština, etc.

Having in mind the new political conditions, assessment of environmental pollution must be made also of the main permanent environmental polluters and their reconstruction. Priority should be given to facilities with big environmental risk for instance in environmental black points in Bor, Trepča, thermal power plants in Obrenovac, Lazarevac, Obilić, etc.

#### (C) REMEDIATION OF “HOT SPOTS” SHOULD BEGIN IMMEDIATELY

Clean-up activities in at-risk areas must begin immediately. Having in mind the present situation in Yugoslavia and the scope and complexity of the activities needed to clean up the polluted areas their implementation will require financial and technical support from the international community.

1. Top priority should first be given to 27 clean-up projects in the four so called "hot spots" in Novi Sad, Pančevo, Kragujevac and Bor, identified in a feasibility study finalized by the UNEP Balkan Task Force in April 2000.
2. Top priority also must be given to identification, assessment and clean-up activities in the areas where NATO used ammunition with depleted uranium.
3. Simple things like aeration tubes, fertilizer applications, containment walls and diversion walls need to be put in place immediately as an interim action to prevent further environmental damage. These temporary measures will also reduce future cleanup costs and the time required to cleanup. The biggest

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advantages here will probably be realized by the fuel spills, though other chemical and metals could also benefit.

4. It should be emphasized that remediation and environmental reconstruction should rely on Yugoslav environmental authorities, enterprises, institutes and professionals (experts) – not consultants and companies from abroad!
5. FRY needs to be very careful about 'Remediation' companies that offer single solutions that the company has the proprietary edge. These products often seem too good to be true and always are. Multiple solutions compared by life-cycle costs, efficacy, and secondary effects with the conventional baseline technology should be considered for every major cleanup project.
6. Innovative technologies should be assessed, having in mind that often the best solution to environmental cleanup is monitored natural attenuation. The environment has a tremendous capacity to cleanse itself, we often make things worse over the long-term by using aggressive remediation techniques.

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