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Panel 3 Report:
Earth Sciences

Volume 4 of 5

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Acknowledgements

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The Review Committee wishes to thank all the people who have contributed to the planning and execution of this evaluation exercise including the preparation of the reports. Our special thanks are due to the members of staff of the BAS Institutes who prepared the Self-Evaluation Reports, thus providing the data without which an evaluation such as this would not be possible. We also owe our gratitude and respect to those whom we met during our site visits and interviews for their frank and open attitude that has helped us greatly in understanding the environment and context in which they operate. We applaud the BAS leadership for its consistent support and its encouragement in applying strict international quality standards to this evaluation, even though the conditions for research in Bulgaria are comparatively difficult. Our understanding is that our findings will be used for the purpose for which they are intended: to improve the quality and impact of research in Bulgaria and we are looking forward to the results.

Finally, our work could not have been done without the support of the staff of ESF and ALLEA. Our special thanks go to Dr. Astrid Lunkes, Dr. Bernard Avril, Dr. Farzam Ranjbaran and Dr. Rüdiger Klein as scientific secretaries of the panels. Dr. Klein and Dr. Ranjbaran also acted as secretaries of the Review Monitoring Committee and coordinated its activities including support to the preparation of the final reports.

Contents

Preamble

This report is prepared by the members of the Panel of Expert (PE-3) assembled as part of the ESF-ALLEA evaluation of the Research Institutes of the Bulgarian Academy of Sciences (BAS). This Panel was responsible for the evaluation of the Research Units (or Institutes) within the Earth Sciences Division of the BAS.

The Panel had six scientific members bringing the required expertise for the evaluation of the 11 Institutes. The members of the Panel are given in the Table shown below. Professor Sierd Cloetingh chaired the Panel, while Dr. Bernard Avril, a member of ESF staff, provided secretarial support.

Title	First name	Last Name	Affiliation	University/ Institute	Country
Professor	Jean	Bonnin	Institut de Physique du Globe	Université de Strasbourg	FR
Professor	Hugo	Decleir	Geografisch Instituut,	Vrije Universiteit Brussel	BE
Professor	Gilles	Pinay	School of Geography Earth and Environmental Sciences	University of Birmingham	UK
Professor	Paul	Tréguer	Institut Universitaire Européen de la mer	Université de Brest	FR
Professor	John	Zarnecki	Planetary & Space Sciences Research Institute	The Open University	UK
Professor	**Sierd**	**Cloetingh**	Netherlands Research Centre of Integrated Solid Earth Sciences	Vrije Universiteit Amsterdam	NL

The present report includes some comments on the evaluation exercise itself the main observations of the Panel at the Division level followed by a set of general recommendations on the mission and its implementation; the promotion of scientific quality and productivity, human resource management, and dissemination; procedures for long-term quality assurance and on the Institute level in Part A. It is followed by the evaluations at the Institute level (501-511 that also include specific recommendations) in Part B.

Part A: Panel-level Report

Overall summary of the Institute-level scores

In this section, the scores given to all Institutes for the three criteria are summarised.

Table 1: Scores for Institutes in the Earth Sciences Division of the BAS

No.	Institute Name	Quality and Productivity	Socio-economic Impact	Prospects
501	National Institute of Meteorology & Hydrology (NIMH)	A	A	A
502	Geological Institute (GI)	B	A	A
503	Geophysical Institute (GPhI)	A	A	A
504	Institute of Oceanology (IO)	A	A	A
505	Space Research Institute (SRI)	B	B	B
506	Institute of Water Problems (IWP)	C	B	B
507	Institute of Geography (IGeogr.)	B	A	A
508	Central Laboratory of Geodesy (CLG)	B	A	B
509	Central Laboratory of Mineralogy & Crystallography (CLMC)	A	A	A
510	Solar-Terrestrial Influences Laboratory (STIL)	B	B	B
511	Central Lab. of Seismic Mechanics & Earthquake Engineering (CLSMEE)	C	A	B

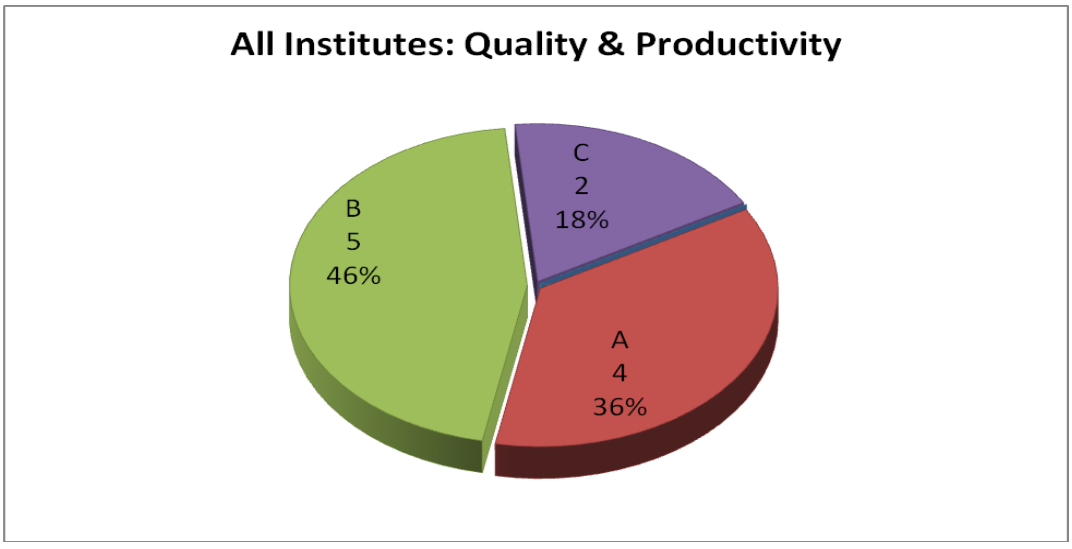

Figure 1: Distribution of Scores for Quality & Productivity for Institutes in the Earth Sciences Division of the BAS

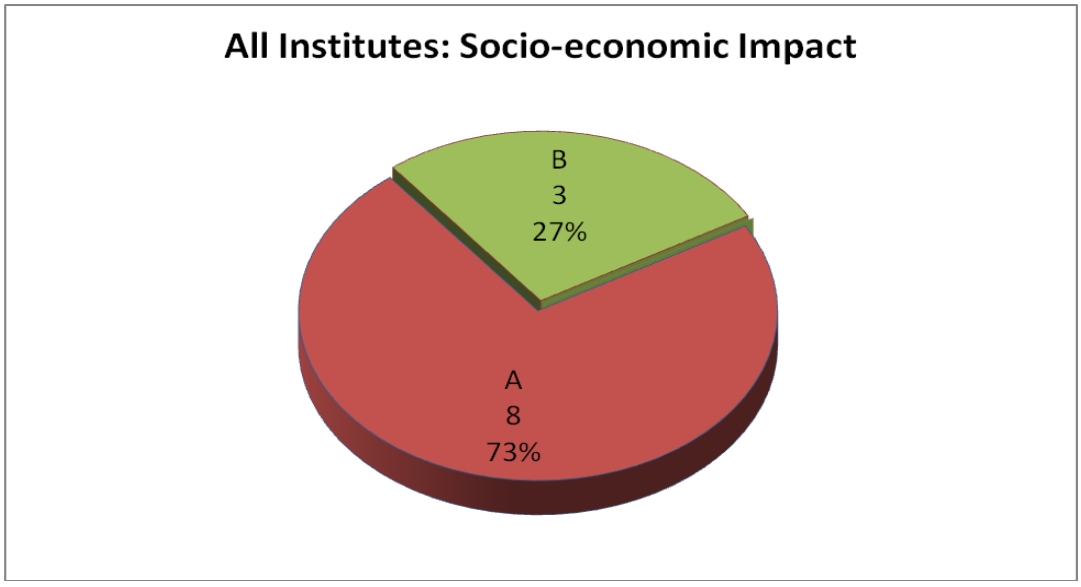

Figure 2: Distribution of Scores for Socio-economic Impact for Institutes in the Earth Sciences Division of the BAS

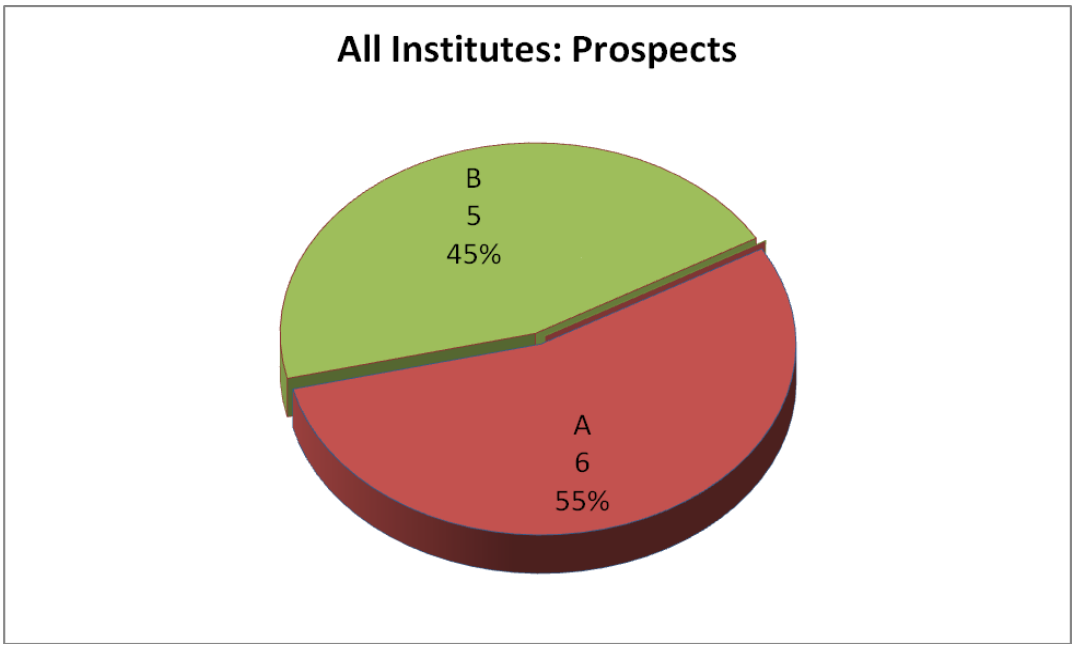

Figure 3: Distribution of Scores for Prospects for Institutes in the Earth Sciences Division of the BAS

Division-wide Executive summary

The field of Earth Sciences is of great scientific and societal importance in particular for Bulgaria. Earth System Sciences require an integrated research framework to address the complex issues and to resolve issues related to for example energy, natural hazards, and the changing environment. Most of the Institutes in the domain of "Earth Sciences" have a dual mission, combining scientific curiosity-driven research with a role as a competence centre responding to the needs of policy makers, addressing questions related to sustainable management of energy, natural hazards and the environment. A balance between internal and external cooperation appears to be necessary in order for the full spectrum of Institutes to contribute to BAS development in the context of the European Research Area (ERA) and according to demands from end-users. However, the embedding of the national research agenda into the ERA and the international research agendas (European Space Agency; Marine Board-ESF; …) appears to be left mainly to the individual Institutes. Similarly, the Panel notices a lack of a vision which should be provided by the BAS central administration to the Institutes concerning long-term relationships and partnerships with other governmental agencies, industry and universities. Overall BAS should foster synergy and coordination avoiding unnecessary internal competition and overlap between adjacent Institutes. Although the project-oriented approach existing in several Institutes can be useful to foster integration, it leads in practice in many cases to a fragmented and short-term approach with little prioritisation for basic research needed to secure innovation potential on the long term and a dispersal of efforts among a large number of small projects, without much visibility and limited return for the Institutes. The Panel has not been able to identify a clear and comprehensive vision for the domain as a whole, and notices the absence of documentation about the overall strategy for its Institutes, about their value or about the BAS expectations in this domain. In a number of cases, the Panel noticed the need for more coordination in terms of project-based development and strategic development and positioning. The Institutes should be encouraged to build up their strengths and helped to develop a long-term strategy within a stable financial environment. Partnership between the Institutes should be encouraged to stimulate complementarity. Mechanisms should be created within BAS and the Institutes to promote role models and to transfer best practice and successful organisational models from one Institute to another. The Panel encourages the setting up of one or several Technology Transfer Office(s) to the benefit of all Institutes in the domain. Finally, the Panel recommends strengthening the dialogue of BAS central administration with the Institutes' leadership to convey fully the intention of evaluation scheme such as the present evaluation as well as their follow-up and consequences.

1. Comments on the setup and procedures of the evaluation

The Panel received written documentation and direct information on the mission of BAS as a whole and on the activities and achievements of the different Institutes in the domain evaluated by the Panel prior to its site visit. Additional information and documents were made available to the Panel during its visit in Bulgaria.

The Panel is positively impressed by the considerable effort made by the Institutes' staff to provide documentation to the Panel concerning their mission, past performance and current activities, and to provide responses to additional general and specific questions of the Panel. The Panel is also impressed in many cases by the positive attitude of the Institutes' staff members and leaders towards this external evaluation. This was the case in particular during the site visits. In addition, the Panel noticed during the interviews that in most cases the leadership of the individual Institutes appreciate the potential contribution of this external evaluation as being of benefit to the realisation of an optimal positioning of their Institutes.

The Panel is not aware of any international science advisory council to assist the Institute leadership in their strategic decisions.

At this stage, it is not clear to the Panel whether the intention exists on the part of the BAS central administration to follow up on this quality assessment with a continuous monitoring of long-term progress at the Institute level and at the domain level.

2. Division-level Assessment of the activities

2.1 Scientific and societal relevance of the domain

The field of Earth Sciences is of great scientific and societal importance in particular for Bulgaria. Earth System Sciences require an integrated research framework to address complex issues and to resolve issues for example related to energy, natural hazards, and the changing environment. This applies in particular to Bulgaria in the context of its geographical location, namely the Black Sea region, the naturally anoxic system of the Black Sea that is unique worldwide, the seismically active region of the Balkans, and the availability of key mineral resources. Similarly, water resources and waste management require high-level expertise at a national and regional level. The domain of space sciences in Bulgaria has been developed as a specific competence, which is not available in every European country.

The overall quality and level of productivity in the Institutes in the domain are found to be high and, in a large number of cases, internationally competitive. The relevance of the overall domain for Bulgaria is unquestionable.

The outlook varies but a number of Institutes in the domain have excellent prospects, whereas a limited number of others should take strong measures to secure or strengthen their future.

2.2 Vision for the domain at large, and potential for integration and added value generation

The Panel recognises considerable potential for the creation of scientific and societal added value by the close cooperation / integration of competences and research agendas of the Institutes in the domain evaluated by the Panel.

The Panel has not identified a clear and comprehensive vision for the domain as a whole, and notices the absence of documentation about the overall strategy for its Institutes, about their value or about the BAS expectations in this domain. Similarly, the Panel notices a lack of a vision provided by the BAS central administration to the Institutes concerning long-term relationships and partnerships with other governmental agencies, industry and universities. The Panel has the impression that these relationships are treated on an Institute level primarily because of a general project-based approach centred on the need to attract third-party funding to provide a remedy for the shortage of basic funding to the Institutes.

Overall, the Panel has the impression that in addressing the challenges, the Institutes develop their own, individual strategy on an opportunistic and sometime ad-hoc basis. Although this might be effective in addressing issues related to the specific context of areas, in which the Institutes operate separately, there are many issues where the Institutes face common challenges, such as recruitment and training of their PhD students, publication policy in peer-reviewed international journals, building up of databases, access and maintenance of high-level equipment and technical expertise, technology transfer to end-users, etc. Similarly, the embedding of the national research agenda into the European Research Area appears to be left mainly to the individual Institutes.

The Panel notices that most of the Institutes have a dual mission, combining scientific curiosity-driven research with a role as a competence centre responding to the needs of policy makers, addressing questions related to sustainable management of energy, natural hazards and the environment. The Panel perceives a tendency to set up the research agenda in a project-oriented framework at the Institute level. The Panel recognises that this is driven primarily by the need to attract external funding. Although such a project-oriented approach can be useful to foster integration, it leads in practice in many cases to a fragmented and short-term approach with little prioritisation of the basic research needed to secure innovation potential on the long term and a dispersal of efforts among a large number of small projects, with limited return for the Institutes. This is regrettable in particular in areas where Bulgaria holds a track record of high-quality research and where it could be of particular value to international partnerships.

2.3 Need for further coordination and strategy for streamlining Institutes' portfolio of activities

The Panel recognises the need for further coordination and streamlining of the efforts made by the individual Institutes to strengthen the position of Bulgarian science in the domain of Earth sciences. The Panel is aware of the specific current context of the Bulgarian science landscape. This applies in particular to the limited budget for science

funding, the need for the modernisation of research infrastructure and for the promotion of capacity building. The Panel has the impression that the BAS central administration could provide strategic support and considerable value to the Institutes by setting up common facilities and guidance, and ways of sharing knowledge and experience. This should be encouraged especially as recent experiences in some of the Institutes have demonstrated their capability of competing successfully in national and international arenas. Mechanisms should be created to transfer such experiences and promote role models to the others. The Institutes should be encouraged to build on their strengths and helped to develop a long-term strategy within a stable financial environment. Partnerships between the Institutes should be encouraged to stimulate complementarity.

Institutes should be encouraged and assisted by the BAS central administration to develop a long-term strategy for their activities. The Panel noticed that some of the Institutes have successfully addressed threats, and problems related to their basic functioning. Within the domain evaluated by the Panel, nuclei exist with high-calibre human resources, leadership and adequate equipment, which would allow the delivery of high-quality research on an internationally competitive level. BAS should cherish and nurture such nuclei, and should capitalise on them. The BAS central administration should provide them with management assistance and facilitate their further development for the benefit of Bulgarian society, and also in view of their potential to be attractive partners in the European Research Area.

The Panel is not aware of a common policy of the BAS within this science domain to encourage and facilitate dissemination and technology transfer. The Panel did not discern any instruments at the BAS level to secure transfer of expertise and sharing of data and knowledge between Institutes in adjacent fields. The Panel has the impression that such partnerships depend, at this stage, on individuals or are driven by short-term considerations and projects. The mandate and remit of the Institutes should also be clarified with a view to such partnerships.

2.4 Instruments and implementation of the mission

Viability, human resources and infrastructure

The Panel recognises the great efforts made by a number of Institutes' directors to secure a viable position for their Institutes. The Panel encourages the BAS to recognise these efforts by promoting the Institutes' leadership officially within the BAS organisation and hierarchy. More generally, the Panel notices the need for a fit between the actual responsibility and the official functions of the Institutes' and sub-units' leadership. The Panel recognises the need to reward efforts to generate added value at the Institute level or between Institutes.

The Panel considers that some concrete measures could be taken to remedy obstacles in the realisation of the mission. This includes:

- Setting up clusters of Institutes in order to build further on Institutes' strengths and to increase added value at the BAS level. Such Cluster would comprise both BAS Institutes and relevant University Units. The Panel would like to suggest for the Institutes in the Earth Sciences Division of the BAS the following clusters:

1. Cluster for Solid Earth Sciences
Geological Institute; Geophysical Institute; Central Laboratory of Geodesy; Central Laboratory of Mineralogy and Crystallography; Central Lab. of Seismic Mechanics and Earthquake Engineering

2. Cluster for Fluid Earth Sciences
National Institute of Meteorology and Hydrology; Institute of Oceanology; Institute of Water Problems; and possibly with other relevant Institutes such as the Institute of Fisheries and Aquaculture-Varna

3. Cluster for Space Sciences
Space Research Institute; Solar-Terrestrial Influences Laboratory

4. Cluster for Geography
Institute of Geography possibly with other relevant Institutes from other Divisions.

- Setting up for the Earth Sciences Division an Earth Sciences Board, formed by the Institutes' directors themselves, and for each suggested Cluster an International Science Advisory Committee, which could monitor the progress in strategic development and could advise this Earth Sciences Board.
- Increasing the collaboration within the Bulgarian Academy of Science and with Universities would create a critical mass to develop further particular objectives.
- Special efforts are required to enhance cooperation between sub-units (eg., departments) to identify common goals and to address the gaps in the knowledge base that are hampering the realisation of these goals.
- In this context, a national equipment plan and access to research facilities is needed. Furthermore, a strategic effort should be organised for the collection and preservation of data and for their open access.
- Measures should be taken to enhance participation in international research programmes and international research organisations, at the individual and institutional level.
- The Panel recognises the presence of a Technology Transfer Office (TTO) in one Institute and encourages the setting up of one or several TTOs to the benefit of all Institutes in the domain.
- Overall BAS should foster synergy and coordination avoiding unnecessary internal competition and overlap between adjacent Institutes. In a number of cases, the Panel noticed the need for more coordination in terms of project-based development and strategic development and positioning.
- BAS central administration could have an important role in providing its Institutes with common research facilities within BAS and set priorities for direct benefit of the Institutes. It is noted that the activities are currently largely directed to intra-academy relations. A balance between internal and external collaboration appears to be necessary in order for the full spectrum of Institutes to contribute to BAS development in the context of ERA and according to demands from end-users.

- The Panel notices that efforts to attract EU funding are now made primarily by stand-alone actions by the Institutes leadership and scientists. This could be better coordinated.
- A pro-active role of the international office of BAS is also important in order to avoid unnecessary duplication of these efforts and secure the dissemination of experiences of successful Institutes and individuals, in this respect to other Institutes in the domain of Earth sciences. This is essential, considering the international, inter-disciplinary nature of the domain evaluated by the Panel.
- The Panel recognises that low salaries of BAS scientists is a universal problem identified by almost all Institutes as the major barrier to the recruitment of bright young scientists. A special effort should be made to advance focused high-level research training in the form of intensive short courses in Bulgarian Universities or Engineering Schools in order to train and attract more scientists in the relevant fields of research. At the same time, high teaching loads associated with teaching of more routine nature disconnected to the core mission of BAS should be reduced.
- The Panel also notices in many cases an unbalanced age structure of Institutes' staff with often too many senior staff, and, correspondingly, not enough junior staff. The Panel is also aware of the "brain drain" of excellent researchers abroad or at least out of the BAS research environment.
- The Panel encourages BAS to develop mechanisms for a systematic promotion of staff and student exchange and to implement mechanisms for re-entry of Bulgaria scientists after research postings abroad. In that context, young scientists have to be encouraged to benefit from existing opportunities through for example, Marie-Curie fellowships, ERC Starting Grants or NATO 'Science for Peace' Programmes.
- PhD students should be stimulated to write at least an extended summary of their dissertation in English for international dissemination. The procedures for the award of the PhD diploma and the DrSc. / Habilitation should be simplified and internationally peer-reviewed and thus accessible also in English.
- Considering the interdisciplinary and international nature of Earth sciences, the Panel recommends the development of joint or dual PhDs diploma schemes and the improvement of access to research facilities and training programmes or resources not always available in Bulgaria. This would also help remedy the brain drain and provide young Bulgarian scientists with attractive perspectives within Bulgaria and encourage them to maintain ties with their home country.
- More rapid individual promotion and rewarding mechanisms should be organised on the basis of objective criteria, known in advance, such as the scientific production and quality, as identifiable in international, peer-reviewed journals and / or capacity to secure third party funding.
- The same is true for dissemination of call deadline and application procedures for staff training and capacity building through the EU Marie Curie fellowships and the ERC Starting Grants. Young scientists should be encouraged to apply, their application facilitated and their successful application rewarded.
- National cooperation across the Institutes is a pre-requisite for preparing Bulgarian contributions to international agencies and initiatives such as the European Space Agency (ESA), the Marine Board of the European Science Foundation (MB-ESF), the

International Lithosphere Program (ILP), the International Continental Drilling Program (ICDP) and the Intergovernmental Panel on Climate Change (IPCC).

Communication, publications and outreach

The Panel is not aware of any BAS-level policy to promote publications in international top-rated scientific journals. However, the Panel recognises that in many cases the individual Institutes' leadership is making considerable efforts to stimulate their scientists to make submissions to such publications. The Panel recognises the need for local publications to document results of local to regional interest and as a possibility for data repository. At the same time, the Panel recognises the great potential of these local journals to disseminate results to the general public and end users at national and regional levels. Yet, where possible, researchers should strive for international visibility of their scientific findings through international, peer-reviewed publications. There is a need to reflect on a more systematic mechanism to conceptualize the existing expertise and make it more visible by publishing in relevant international journals. Training should be provided in this respect, especially for young researchers.

Scientific seminars jointly organised by the Institutes within the research domain and between adjacent research domains should be encouraged and facilitated.

The Panel notices only a few cases where there are specific efforts toward public outreach and wide dissemination of scientific findings. Outreach to schools, universities, the general public, policy-makers and media should be encouraged and facilitated. In some cases, it could prove crucial for the Bulgarian society at large, especially in raising awareness toward natural geohazards (in particular: global warming, earthquakes, floods, landslides).

2.5 Synergies and overlaps

In general, there is a limited overlap between the different Institutes in the domain. At the same time, some of the activities of the Institutes need an enhanced level of coordination within and between Institutes, within the domain and possibly with adjacent domains. Promising steps in this direction have been or are being made in setting up schemes for joint research infrastructure requiring coordinated efforts by at least three Institutes in the domain.

The Panel does not directly recommend merging of Institutes for budgetary reasons only. If options for merging Institutes are considered by BAS, the prime criterion should be added value generation, building critical mass around existing strengths.

In view of the viability of some of the smaller Institutes, measures should be taken to strengthen their interface with other organisations active in adjacent fields. This applies for example to an integration of the Central Laboratory for Geodesy and the Geophysical Institute. The latter Institute has shown a strong ability to promote innovation, as illustrated by its recent setup of a highly competitive paleomagnetic research group. The Panel recognises that the Central Laboratory of Seismic Mechanics and Earthquake Engineering to a large extent has its own niche in geo-engineering and site selection for

strategic, national infrastructure. At the same time, the interface in this field with the Geophysical Institute needs to be strengthened.

Some sort of "cross-institute" (= "horizontal") programme could be advantageously developed within the Earth Sciences Division of the BAS. In other words, the Panel recognizes the need for integration with other BAS Institutes and Laboratories, in particular in solid Earth observatories, such as with the Central Laboratory of Geodesy and the Central Laboratory of Seismic Mechanics and Earthquake Engineering, leading to a coordinated instrumentation pool. More specifically, the Panel advises BAS to explore the setting-up of a consortium of at least the Geophysical Institute and Geological Institute plus possibly some other relevant Institutesfor deep seismic reflection profiling of the Bulgarian crust and lithosphere. This would provide a highly needed basis for modern process-oriented research in the Solid Earth Sciences in Bulgaria.

In addition, the Geological Institute has a very important role as a competence centre for the safe management of the sub-surface. At the time, it has strong potential interfaces with a large number of the other Institutes, including the Geophysical Institute, the Central Laboratory of Seismic Mechanics and Earthquake Engineering, the Central Laboratory of Mineralogy and Crystallography, and this should be fully taken into consideration.

Similarly for the National Institute of Meteorology and Hydrology, and the Institute of Water Problems, plus possibly some other relevant Institutes, further integration of research in the domain of water resources and management is required, as well as its integration with meteorology.

A promising effort has begun with the setting up of joint facilities in geoinformatics, between the Institute of Geography and the Solar-Terrestrial Influences Laboratory. The need for a national long-term policy for space sciences and for strengthened cooperation and coordination between the Space Research Institute and the Solar-Terrestrial Influences Laboratory is obvious, taking into account their respective history and current portfolio of expertise. Such efforts are particularly important in the context of securing the Bulgarian membership in European Space Agency.

The Central Laboratory of Mineralogy and Crystallography is a high-quality research unit, which is a nucleus for high quality infrastructure and can serve as a role model for best practice in attracting young researchers. Yet, it should strengthen its vision for future development.

Research in marine science is well on its way to promoting excellence and appears to be well coordinated; the strengthening of already established research and higher education links at the Black Sea area level, and at the European and international level are strongly encouraged. To structure and strengthen the marine sciences at the national level and especially the Institute of Oceanology, BAS should take the initiative of creating a cluster of excellence in marine sciences and resources.

3. Division-level recommendations

3.1 Recommendations about the mission and its implementation

- Mechanisms should be created within BAS and the Institutes to transfer best practice and successful organisational models from one Institute to others.
- The Institutes should be encouraged to build on their strengths and to develop a long-term strategy within a stable financial environment.
- Partnership between the Institutes should be encouraged to stimulate complementarity.
- Institutes should be encouraged to develop a long-term strategy for their activities.
- BAS should cherish and nurture nuclei of high scientific quality and productivity, and should capitalise on them. BAS should provide them with management assistance and facilitate their further development for the benefit of Bulgaria society, and also in view of their potential to be attractive partners in the ERA.
- The mandate and remit of the Institutes should also be clarified with a view to such partnership.
- The Panel recognises the need to reward efforts to generate added value at the Institute level or between Institutes.
- Measures should be taken to enhance participation in international research programmes and international research organisations, at the individual and institutional level.
- A national equipment plan and access to research facilities is needed. Furthermore, a strategic effort should be organised for data management, which includes the collection and preservation of data and metadata, and for their open access using international standards.
- Regarding the transfer of knowledge to industry, the Panel recommends that BAS consider building clusters that includes the economic, research and higher education stakeholders that are willing to combine and increase their capacity for innovation and are encouraged to lead R&D projects. Especially, the presence of a Technology Transfer Office (TTO) in one Institute is positively viewed by the Panel that encourages the setting up of one or several additional TTOs to the benefit of all Institutes in the domain.
- Overall BAS should foster synergy and coordination rather than unnecessary internal competition and overlap between adjacent Institutes.
- Outreach to schools, universities, the general public, policy-makers and media should be encouraged and facilitated.
- The Panel recommends a fit between the actual responsibility and the official functions of the Institutes' leadership.
- Provide the Institutes with access to support facility of BAS and prioritize the BAS central administration duties for direct benefit to the Institutes.

- A pro-active role of the international office of BAS is needed in order to avoid unnecessary duplication of these efforts and secure the dissemination of experiences of successful Institutes and individuals, in this respect to other Institutes in the domain of Earth Sciences. This is essential considering the international, inter-disciplinary nature of Earth sciences.
- Special efforts should be made for dissemination of call deadline and application procedures for human resources training in the EU Marie Curie fellowships and ERC Starting Grants. Young scientists should be encouraged to apply, their application facilitated and their successful application rewarded.
- Promote 'horizontal' (= 'cross-Institute') themes with some sort of co-ordination, especially for natural geo-hazards [global warming, earthquakes, floods, landslides,...]; for waste disposal and water quality preservation; or for applications of GPS techniques.
- National cooperation across the Institutes is a pre-requisite for preparing international cooperation to be put in place within international agencies and initiatives such as ESA, MB-ESF, ILP, ICDP and IPCC.
- Considering the largely complementary expertise of the laboratories and Institutes mentioned above the Panel recommends the creation of a BAS cluster in Integrated Solid Earth Science, in close coordination with pertinent university teams. This would allow them to set up the planning and coordination of large-scale innovative programs such as the deep seismic reflection imaging and other innovative approaches required for the quantitative assessment of Bulgaria's georesources and geohazards.

3.2 Recommendations about the promotion of scientific quality and productivity, human resource management, and dissemination

- Where possible, researchers should strive for international visibility of their scientific findings through international publications. Training should be provided in this respect, especially for young researchers.
- Regular evaluations of individual scientists should be carried out, with promotion schemes taking into account the results of these evaluations.
- The Panel encourages BAS to develop mechanisms for a systematic promotion of staff and student exchange and to implement mechanisms for return of Bulgaria scientists after research postings abroad.
- Young scientists should be encouraged to benefit from existing opportunities through for example, Marie Curie fellowships and ERC Starting Grants.
- The Panel encourages BAS to recognise actual leadership efforts by individuals in the responsible positions by promoting these individuals also officially within the BAS hierarchy.
- Scientific works accomplished in Bulgaria should not remain confidential, but rather be accessible by a significant community of foreign scientists.
- PhD students should be encouraged to write an extended summary of their dissertation in languages other than Bulgarian. The procedures for the award of the

PhD diploma and the DrSc. / Habilitation should be simplified and internationally peer-reviewed, and thus should be also accessible to an international audience.

- Considering the interdisciplinary and international nature of Earth sciences, the Panel recommends the development of joint or dual PhDs and the need for access to facilities and training not always available in Bulgaria. This would also help remedy the brain drain and provide young scientists with attractive perspectives and encourage them to maintain ties with Bulgaria.
- Joint seminars within the research domain and between adjacent research domains should be encouraged and facilitated.
- Special efforts should be made to enhance cooperation between sub-units (eg., departments) and to identify common goals and gaps in the knowledge base hampering the realisation of these goals.
- More rapid, individual promotion and rewarding mechanisms should be organised on the basis of objective criteria, known in advance, such as the scientific production and quality, as identifiable in international, peer-reviewed journals and / or capacity to secure third party funding.

3.3 Recommendations on procedures for long-term quality assurance

- The Panel recommends securing effective implementation of the findings of the international quality assessments including the present evaluation.
- The Panel recommends effective communication of the findings of the international quality assessments of Bulgarian science, including the present evaluation, to the Institutes' leadership and the scientific community in the Institutes.
- The Panel recommends the follow-up of this evaluation by setting up a mechanism of monitoring of progress by an international Panel.
- The Panel recommends that the next evaluation exercise be prepared, taking into account the present evaluation, the progress made since then, in consultation with the Institutes' leadership and the scientific community in the Institutes.
- The Panel recommends that a SWOT-analysis be performed at domain level.
- The Panel recommends the setting-up of a coherent vision at domain level, to be provided to the next international Panel prior to the next evaluation of the individual Institutes.

Part B: Institute-level Reports

National Institute of Meteorology & Hydrology (NIMH) - 501

Executive Summary

NIMH, established in 1989, is a major BAS Institute in meteorology, agro-meteorology and hydrology. NIMH serves as national weather forecasting service, providing the government, municipalities, public services and the media with daily and special forecasts. It also manages the national meteorological and hydrological networks and archives and communicates the data produced by these networks.

NIMH consists of 4 Departments: Meteorology, Hydrology, Weather Forecasting and Composition of the Atmosphere and Hydrosphere. The latter department is split into 4 divisions: Information, Telecommunication, Central Meteorological Observatory and Regional Centres. Relatively little information was provided about operational activities, the functioning of the network of observational stations as a whole and the regional centres (Plovdiv, Pleven, Varna and Kyustendil) in particular.

In total, the NIMH has 730 employees. The academic staff consists of 42 senior research fellows (Professors and associate Professors) and 42 junior research fellows (Dr Sc and PhD). The supporting staff consists of 646 employees. 556 employees are working outside the central office. The average age of the personnel is over 53 years, of the 42 professors only 5 have an age below 50, so there is a serious gap between generations. NIMH takes up a limited number of educational activities in universities, as post-graduate training and specialization courses. The governing body consists of a Director General, 3 Deputy Director Generals and 1 Scientific Secretary. During the 2004-2008 period, 15 PhD students were active in the Institute. The number of foreign visitors is very low. No mention is made of internal meetings, reports and seminars.

The evaluation shows that the NIMH is functioning well both at the national and international level. The products and services it delivers are numerous and highly relevant for the functioning of the Republic of Bulgaria and the wellbeing of its inhabitants. The research carried out in support of its activities is of good quality and well integrated in the European and global context.

(a) Quality and productivity

By decree of the Council of Ministers, NIMH has a number of important obligations in the field of meteorology (weather forecasting: short, medium, long-range; sea wave forecasts, early warnings of dangerous weather), hydrology (investigation of surface and groundwater resources, short-term and long-term hydrological forecasting, mathematical modelling of the fluctuations of surface- and groundwater flow), agro-meteorology, composition of atmosphere and hydrosphere (dispersion and transport of pollutants, chemical composition and radioactivity background of air, surface and ground waters). NIMH thus delivers an important amount of products and services to the government, general public and scientific community. In order to achieve this, it has developed a well-organized nationwide observation system consisting of 4 basic hydro-meteorological networks and a modern data archive going back at some places to more than 130 years.

NIMH is also the official representative of Bulgaria in a number of European and World organisations, such as the WMO, EUMETSAT, EUMETNET-OPERA (Operational

Programme for the Exchange of Radar Information), UNESCO's International Hydrological Program, the International Association for Danube Research. NIMH is one of the 15 Regional Telecommunication Hubs (RTH) of the WMO, a co-ordinated global system of telecommunication for the exchange and distribution of observations and processed information within the framework of the World Weather Watch.

The scientific research underpinning these activities covers a broad range of subjects. 53 projects, out of a total of 179 projects carried out in the period 2004-2008, were financed on BAS own budget or with additionally funding of the National Science Fund (NSF). During the same period, 47 projects were financed by contracts with ministries and/or private companies. The largest amount of projects (55) was financed according to contracts and programs of EU, NATO, UNESCO or other international bodies. 15 projects were funded as a result of bilateral agreements, among which a number of contracts with METEOFRANCE in the framework of the 'Aladin' high-resolution weather forecasting model for Southern Europe. NIMH takes an active part in the Phare Programme and Framework Programs 5, 6 and 7. It also takes part in several COST (European Cooperation in Science and technology) Actions.

Through its activities NIMH contribute to the implementation at a national level, Bulgaria's commitments to the Intergovernmental Panel on Climatic Change, the United Nations Framework Convention on Climatic Change and the Kyoto Protocol, the Convention to Combat Desertification, the EU Water initiative, etc.

The total number of publications during the last 5 years amount to 517 or a mean of 104 publications per year. There were 65 publications in – generally - peer-reviewed international journals and 43 in Bulgarian journals. The publications in the form of abstracts or proceedings of international congresses or symposia amount to 252, those in Bulgaria to 91. Further 18 publications of books or chapter in books outside Bulgaria and 9 in Bulgarian were also noted. The international recognition is therefore good, although the total publication amount is not overwhelming since it concerns a significant amount of researchers (84). Especially in the field of hydrology, the output in peer-reviewed journals is low. The total amount of citations is 5270, from which 2880 in international scientific journals.

Overall score for Quality and Productivity: "A", for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

(b) Socio-economic Impact

The priority of the NIMH is the operative activities and this is understandable in view of the many obligations, both national and international. The infrastructure - at least at the central agency - appears up to date including the computer and communication hard- and software. The services and products delivered by the Institute are therefore highly relevant. However, in view of the magnitude of the Institute and the broad spectrum of activities, and because of the strategic goal of BAS to become an 'engine of the knowledge-based society', greater emphasis on and output in the pure scientific field should be aspired. Although more than 90% of the science is applied, contracts with or funding from industry is minimal.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

In view of the nature of the object – and the importance of the problems involved - studied within the NIMH (disaster weather, flooding, drought, global warming…) and its socio-economic impact, given also the European and even global connection, the vitality and feasibility of the NIMH projects seem to be guaranteed. However, the emphasis on fundamental research is generally too low and such research is - among - other things essential for attracting young and motivated scientists and maintaining the overall quality in the more applied field.

The science plan is steered by national and international priorities and this will continue in the future. To a large extent, they will be determined by the introduction of new technologies and practices in the observation field, in the information transfer and communication domain. An example is the automatic stations for weather and hydrology (for instance underground measurements!) radar and computer systems. Many new directions are imposed by the obligations of the NIMH due to its membership in the WMO and other international organisations. Such new technologies and practices of course require a higher level of competence among the staff members, and the remedy to this is to attract young scientists but this is largely a financial problem. Salaries on offer in the Institute are not attractive! Another aspect in this context is the sharing by the senior staff of the operative and administrative activities allowing young scientists to participate more in challenging scientific activities. Without strategic solutions of the management concerning the age distribution problems, the abundant teaching problem and the brain drain of members of IMI it will be difficult to overcome the problems listed in Sec 4. of the SER.

Overall score for Prospects: "*High.*"

Overall Strengths and Weaknesses

NIMH possesses highly qualified and skilled research staff both in the field of meteorology and climate as in the domain of hydro- and agro-meteorology. NIMH has a significant output and is fairly well integrated in Europe and elsewhere. However, the exchange with European scientists is in one direction. Few scientists from abroad visit the NIMH. NIMH is a Regional Telecommunication Hub of the Global Telecommunication System of the WMO and controls the information flow from countries of South-West Europe, and Greece, Cyprus, Romania, Turkey, Macedonia and former Yugoslavia. The integration with other national state institutions is not optimal. There are a lot of overlapping activities with other BAS Institutes, while there appears also a problem with the (free) data exchange.

Strengths:

- High qualified research personnel
- Well developed observation network
- Implementation of modern techniques in forecasts
- Significant scientific output
- Participation in European and global networks
- High number of internationally financed projects
- Regional Telecommunication Hub.

Weaknesses:

- Lack of young staff
- Too many employees with unclarified duties
- Relatively low number of peer reviewed international papers
- Lack of fundamental research
- Funding over- fragmented
- Low number of contracts with industry
- Overlap with several other BAS Institutes.

Recommendations

More emphasis on fundamental research is required and higher level of publications in international, peer-reviewed journals. The level of participation in European and global networks should be maintained or even increased. The same applies to the number of exchange students and foreign scientists visiting NIMH. Also more seminars and open discussions should be organised. In view of the importance of meteorological and hydrological data for the society in general and for the broad range of scientific users, a more open (at minimal cost), access to the data is advocated. Overlap in research activities with other BAS Institutes should be avoided. The available technical scientific expertise in the NIMH should yield a greater number of (and more substantial!) contracts with industry and private companies in general. The total number of employees in the NIMH is large and this might result in future budget problems. With a good policy regarding the introduction of automated observations, a substantial reduction in the number of employees can be achieved without diminishing the overall quality.

Geological Institute (GI) - 502

Executive Summary

GI has definite assets in the domain of basic and applied Geology: good coverage of activities traditional within the discipline, well-developed co-operations with many organizations, both inside and outside BAS; good visibility worldwide in the discipline, though publications in world-renowned journals could be further developed; good professionalism in analytical work; relatively good distribution of personnel as a function of age, although more young scientists are desirable.

The research portfolio is of great societal relevance. The portfolio is well positioned in terms of foci on, for example, waste management, water quality, paleoseismology, energy resources and mineral resources. At the same time, the Institute is a national competence centre for core expertise in fields such as tectonics and structural geology and paleontology/stratigraphy. It is essential that the expertise and geological data is well maintained to allow its full use in the applications to projects of great societal relevance. To this end, a vigorous forward-looking thematic research programme, covering the coupling of deep Earth and surface processes in Bulgaria, is necessary. Such a programme by its nature needs a strong fieldwork component and could be connected to international research efforts such as the ESF EUROCORES Programme TOPO-EUROPE.

The main issue for the future is to have a balanced portfolio between 'curiosity-driven' activities, i.e. focusing on basic science, and 'demand-driven' activities. This is challenging but could also lead to a service-oriented Institute. Therefore, the mission of GI within BAS should be clearly defined and implemented.

A domain to be promoted further is the research-oriented activity dedicated to geological hazards, in close co-operation with other organizations inside and outside BAS.

(a) Quality and productivity

Quality

The total staff number (close to 160) makes the GI a rather large organization. The age distribution is not far away from a reasonable balance as far as researchers are concerned, although the peak could be more favourable to younger scientists. A striking feature is that high-ranked positions are occupied by rather old scientists. Although high-ranking can be associated with accumulation of professional experience, it appears more likely that promotion is mainly governed by "seniority". No researcher with an age below 46 years has a "Senior Research Fellow Degree II" position. Together with the overall salary situation in the science domain in Bulgaria, this does not make it easy to attract bright, young scientists.

The organization-of-research process has been satisfactorily documented, although some issues deserve more explanation. For example, "the Scientific Council is [allegedly] authorized from the Highest Attestation Commission to the Council of Ministers of Bulgaria to administer 8 geological disciplines. This should be changed, also in terms of the 8 geological disciplines authorized and the disciplines (if any) that are not authorized. The internal evaluation procedure for research includes regular three-

month short reports. It is unclear to the Panel whether annual financial bonuses for the researchers are granted as additional personal earnings for the relevant scientists or as additional funds for the projects they are working on. It is also not fully transparent who decides on these bonuses.

Some properly documented information has been provided on the overall academic achievements and the most important applied results for the last few years. However, the Panel would have appreciated a brief professional description (1-2 pages) of some (2-3) achievements/results that the GI considers as major contributions within the reference period. To some extent this has been alleviated by the presentations given during the Panel's visit to the Institute, with many posters demonstrating the wide range of interests of the present-day Institute. The immediate future of the Institute could have been better characterized by selecting more sharply the most promising topics.

Although a large institution like the GI does need a significant budget for its daily operation, the project-based scheme of financing is not likely to offer a clear image of the GI's finances and activities. Without going into detail (like cross-subsidy of financial support among the various projects implemented), this requires investigating much more deeply the finance mechanisms in force within the BAS units.

A large number of projects has been reported, which is to be expected considering the size of GI. Some information has been given on the participants in the different projects. Participation of GI members is described in terms of number of scientists involved. It is often less clear regarding participation from outside GI. It is without an indication of the percentage of work-time dedicated by participants to an individual project, sometimes difficult to assess the relative importance of each project. The general impression of the Panel is that the activity of many researchers is very dispersed over different projects. The relevance of the projects to a particular area is sometimes poorly identified. At the same time, hydro-geological topics have an outstanding importance in the Institute. Limited information has been provided on the funding of the projects. The break down of the list of projects according to years should have be supplemented by documentation on the long-term policy.

The distribution of personnel according to age, shows a marked peak at 46-50, including the "Senior Research Fellow Degree II". There could be more higher-ranked staff in the younger classes. "Senior Research Fellows Degree I" are all over 56, and the two corresponding members of the Academy are over 70.

Productivity

The GI's scientific staff is markedly involved in international exchanges, many publications have been generated by these exchanges. The GI's scientific staff is also active in participation in editorial boards of scientific journals. Yet, it is not always explicit why certain GI projects have not generated publications.

The lists of publications in all categories are impressive, as well as the numerous publications in high-ranked scientific journals. It shows that GI's scientific staff is aware of the importance of publishing results.

22 students are engaged in PhD studies, with only five actually awarded a doctorate (1 out of 4). It is unclear whether the others were hired in the very last years of the period

without defending yet their thesis. There could also be a gender problem: two females out of 14 (14 %), but three males out of 8 (37 %) have finally been awarded their PhD.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

(b) Socio-economic Impact

Some sort of a "geological institute" is obviously a "must" within an organization such as the BAS.

A striking feature is the very large potential overlap between GI and several other BAS research units, namely the Geophysical Institute, the Central Laboratory of Mineralogy and Crystallography, the Central Laboratory of Seismic Mechanics and Earthquake Engineering, the Institute of Water Problems, and to a lesser extent the Institute of Oceanology, the National Institute of Meteorology and Hydrology, the Central Laboratory of Geodesy. The precise nature of existing collaboration is not always clear and it seems that existing collaboration actions are mainly the result of individual initiatives rather than a policy of the Institute except in the case of acquisition of advanced analytical instruments. A more systematic approach is recommended.

The collaboration with the Bulgarian university system is fairly well developed and convincingly presented. Co-operation "with other research institutions" is very much emphasized. At the same time, conducting research projects that need the implementation of specific, advanced techniques (like GPS, SAR, remote sensing in general), in practice requires the active co-operation of specialists from other organizations.

Overall the scientific staff has a remarkable teaching commitment (in the broader sense). Although pro-active involvement in research training is appropriate, in some cases the teaching activity tends to an almost full-time teaching workload. This situation looks somewhat unbalanced as the number of students (PhD, MSc, Bachelor degrees) is not very large.

Some GI's staff act as experts, but documentation is lacking on how many staff are actually involved.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

A major case has been made on the analytical equipment as a means for the future development of the GI. Although the analytical equipment available at GI in 2008 and its capabilities has not been fully documented, there is no doubt that up-to-date, high-capacity analytical equipment is needed. Furthermore, analytical equipment has become so sophisticated and expensive that it requires the corresponding highly trained personnel to drive the underlying science. This is obviously not trivial in the context of employment in science in Bulgaria in general and within BAS in particular. In addition, investing in sophisticated equipment inevitably leads to offering services to a community of users that is as large as possible. This is very much work-force consuming, especially in terms of personnel, though it probably brings in some additional income. An approach promoting high level scientific results appears more appropriate than the

objective to develop analytical capabilities as such. It became evident on the occasion of the Panel visits to the Institutes and the interviews that the acquisition of new, advanced analytical tools is now a problem that several BAS Institutes have in common. Furthermore, some instruments are already to be bought by consortia of Institutes (like the ICPMS-LA, with the CLMC).

The future development of the GI is seen by the Institute as based on a "'demand driven' approach rather than a 'curiosity driven' one". If the former has not been given priority in the recent past and although it deserves attention, the latter cannot be disregarded.

A "personnel development policy" has been formulated. In theory it is based on generalized competition, although this was not evidenced on the Panel's visit to the Institute, nor in the interview with the management. The Panel recognizes that competition is an essential mechanism of progress in science; at the same time, it does not favour over-competitive behaviour, in particular when backed by financial rewards. As science is not on the same footing as basic trade, this way of "fuelling" scientific activity is very delicate to manage day to day and bears risks in the long term.

The role of GI in the future has been addressed, mainly in very general terms. This is understandable when dealing with such a large unit, which offers outstanding services to the whole country. However, some additional information would have helped the Panel to have a good sense of the effective role of GI in the Bulgarian landscape. It is, for example not fully clear in Bulgaria whether the GI has the role usually played by geological surveys or equivalents in many other countries. Because of historical developments, there appears not to be a "geological survey" properly-speaking at this moment in Bulgaria. The GI fulfills practically and partially the role of such an organization. It is outside the scope of this evaluation, whether Bulgaria should organize such a "survey", but GI would certainly greatly benefit from a clarification of its mission in the near future.

Overall score for Prospects: "*High.*"

Overall Strengths and Weaknesses

Strengths:

GI has significant strengths: it is a reasonably large Institute; but questions remain on its organizational flexibility. It is well involved in the traditional activities in its scientific discipline, both field-work and analytical work; overall, it produces significant results published in world-renowned journals, though its publications could be more numerous; the balance between the different sub-units is difficult to assess. Numerous and efficient co-operation with many organizations, both inside and outside BAS, is certainly an asset.

Weaknesses:

Weaknesses stem partly from its strengths. In particular, the good quality of analytical activities is likely to generate some type of inflation: better and usually very expensive analytical instruments, demanding well-trained maintenance/operating personnel, might sooner or later interfere with pure research considerations. In this context, analytical activity on demand from outside does not always generate basic scientific innovation and publications. In particular, the problems raised in attracting young scientists either for service analytical

activities or for basic science, lead obviously to shortcomings in terms of overall scientific policy of the Institute's units engaged in analytical work.
The relevance for scientific and socio-economic impact is high, and the prospects to tackle new scientific challenges are high.

Recommendations

- The general impression of the Panel is that the GI would benefit by focusing increasingly in parallel with the basic, high-quality activities it has developed, on topics like geo-hazards, which are already addressed but are likely to generate more societal demand in the near future. This will, no doubt, require more extended co-operation with many other organizations, possibly in terms of a “cross-institute” topic/programme, federating the contributions of the different BAS units involved in these topics. This would also increase the visibility of a sub-set of BAS Institutes vis-à-vis Bulgarian society as a whole and would give the Bulgarian scientists involved the critical mass for a significant participation in numerous international programmes underway in that domain.
- Further strengthening of the collaboration with the Geophysical Institute appears to be logical. In this context, a gap is noted in deep seismic reflection seismics, a technique of great importance in mapping the subsurface. For the interpretation of the seismic reflection data, geological expertise is vital, in particular in the domain of structural geology. Another gap is noted in the domain of quantitative modelling of geological processes. GI is advised to fill in this gap, which would also allow the GI to advance in geo-prediction, reservoir studies and geothermal energy. Basin modelling would be of particular importance in this context.
- A strong collaboration is advised with the Institute of Oceanography to secure a stronger backbone for marine geology in Bulgaria and to link onshore geology closely to the offshore record.
- Staffing of GI could certainly be increased, especially as the GI has de facto or de jure some of the duties of a “geological survey” for Bulgaria.

Geophysical Institute (GPhI) - 503

Executive Summary

GPhI has very good assets within its domain (seismology, Earth's magnetism, gravity, atmosphere, ionosphere, UV radiation) and is well in phase with the international trends of science development. The main concern of the Panel is related to internal organization, regarding especially the relationship between "pure" basic science and monitoring activities. Potential overlaps with other BAS Institutes, and the problems of personnel, in particular attracting young scientists, should be carefully addressed. In addition it is recommended to pay more attention to geological hazards/risks (in co-operation with other organizations), evidently important for the country.

(a) Quality and productivity

Quality

GPhI is "one of the main scientific institutions in Bulgaria" with a dual mission: permanent monitoring (earthquakes, magnetism, gravity, UV radiation, ozone layer thickness) and basic/applied science ([seismology, paleomagnetism, atmosphere physics). Accordingly, its internal research organization is strongly bipolar: monitoring activities versus project-oriented research activities.

Because of the permanent monitoring tasks, a large number of staff is located in observatories/stations all over the country.

A major effort in renovation and significant improvement of equipment in all departments of GPhI, including monitoring services, in the period 2004-2008, is noted by the Panel.

"Real-time determination of the earthquake parameters" is performed. The monitoring network includes 31 seismographic stations with broad-band 3D instruments. International exchange of data is well organized: with CTBTO [Test Ban Treaty Organization] central unit (Vienna, Austria); with EMSC and ORFEUS (through a Data Request Manager [DRM]).

The paleomagnetism group is an example where a remedy has been found against brain drain. The publication record of this team is outstanding. The team holds a rather unique secular variation database. Co-operation with NIMH in paleoclimatology could be further developed.

Most important applied-science activities include tasks related to the NIMH, and tasks related to the monitoring mission of the CLSMEE.

Relevance to industry should be more explicit, also in view of contracts originating from industry (e.g. Lufthansa Teknik). It is also recommended to be more explicit in terms of openness of GPhI to Bulgarian societal demands.

Productivity

The number of projects appears to be very large: 123 Projects involving 551 participants reported. A research fellow appears as participant in an average of about 12 projects; thus devoting, as an average maximum, 8 % of his/her work-time to each

project. The concept of "participants in a project" is not clearly defined and the average involvement of scientists in the projects listed is not always clear.

In the report of publications, a more strict differentiation is required: the "*Bulletin d'Information des Marées Terrestres*" has little to compare with e.g. the "*Geophysical Journal International*", both included in the lists under "international peer-reviewed journals". Nevertheless, the lists are in general impressive.

Overall score for Quality and Productivity: "A", for **"***work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

(b) Socio-economic Impact

The Panel noticed that:

- Extensive collaboration exists at the European level through many different projects funded by various organizations (EU FPs, INTAS, COST, JRC, NATO "Science for Peace"…).
- Regional and bilateral co-operation are well developed.
- Overall, the involvement of GPhI's scientists at international level is very good. At the same time, there is a surprising lack of participation in editorial boards of international journals.

The respective roles of GPhI versus the GI (e.g. in deformation of the Earth's surface, active tectonics), the Central Laboratory of Mineralogy and Crystallography (e.g. in synthesis of diamonds), Solar-Terrestrial Influences Laboratory (e.g. regarding the ionosphere), the Central Laboratory of Seismic Mechanics and Earthquake Engineering (e.g. in seismic hazard/risk, seismic zoning, active tectonics) are not always clear, although it is obvious that active co-operation does exist. Further streamlining is needed to make sure that mechanisms for harmonious and productive co-operation are durably implemented. In particular, space exists for further integration with the research agenda of the BAS GI.

The societal role of GPhI is obvious and should be preserved and further developed, via emergency earthquake source parameters determination and structural contacts with civil authorities; via ionospheric observations/forecasts, in co-operation with the Ministry of Defence; via geomagnetic observations, in co-operation with the Cadastre Agency and the Military Cartographic Service of the Bulgarian Army; via ambient air quality and stratospheric ozone layer monitoring in co-operation with environment governmental agencies.

An overall good involvement of scientists in teaching activities is noted.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

One Academician; 1 corresponding member of Academy; 1 senior research fellow Degree I; 2 senior research fellows Degree II; 2 DSc; 3 PhD granted, are reported: this looks like a good achievement, when taking the overall Bulgarian context in account. Apart from the full/corresponding members of Academy who are selected

independently from the Institute, the overall status of the Institute will probably lead to better achievements in the future, especially regarding the PhD awarded.

Over 28 scientists (out of 120 total staff, or 46 research fellows) are listed, the average age is roughly 46, with a strong dominance of scientists over 50 in the higher positions, and < 45 for the lower positions. The trend could be more favourable for the future, with attention to promotion of younger scientists to higher positions.

Extensive co-operation with university departments is evidenced, according to the joint projects and publications lists reported. Nevertheless, the Panel stresses the importance of making more efforts to involve students. GPhI does not attract foreign PhD students and the mismatch between the number of PhD students and the PhDs granted, over the reference period, is striking. Clearly, the situation definitely deserves action.

GPhI makes repeatedly reference to the advent of the "knowledge society". In spite of this, it is not warranted that this "knowledge society" will have significant impact on GPhI. GPhI would be well inspired calling upon more concrete incentives to develop its future plans.

Overall score for Prospects: "*High.*"

Overall Strengths and Weaknesses

Strengths:

The GPhI has significant strengths in many fields: it is a well-managed Institute with a very interesting portfolio; excellent monitoring equipment/organization; accumulated data/experience in paleomagnetism; well-developed co-operation, both at the international and the national (including BAS) levels; good publication records; recent upgrading of monitoring tools.

Weaknesses:

Its weaknesses relate mainly to staffing in general. Many staff members are currently assigned to tasks dedicated to running/maintaining decentralized observation sites. It is likely that tasks are going to change radically and become less demanding in terms of personnel in the future, leading to an important mutation in the GPhI staff as a whole. Another aspect, obviously clearly related to the above, is the hiring of "fresh blood", which does not appear straightforward within the general economic/employment environment prevailing currently in Bulgaria.

Recommendations

GPhI is well along the lines currently followed internationally in solid earth geophysics: this should be continued. In matters of monitoring, efforts should be pursued; in particular in seismic monitoring, in following the international trends in data storage, processing and exchange; this activity should not be separated from basic research as it is actually part of it, with respect to monitoring equipment, data processing and interpretation.

In "outer" geophysics (UV radiation, ozone layer monitoring), some clear assignments should be arranged with other BAS Institutes (STIL, NIMH), not necessarily by transferring responsibility from one institute to another, but by clarifying respective responsibilities.

Some “cross-institute” (= “horizontal”) programmes could be developed within the Earth Sciences Division of the BAS. The Panel recognizes the need for integration with other BAS Institutes and Laboratories, in particular in Earth observatories, such as the Central Laboratory of Geodesy and the Central Laboratory of Seismic Mechanics and Earthquake Engineering, leading to a coordinated instrumentation pool. More specifically, the Panel recommends to explore the setting-up of a consortium by the Geophysical and Geological Institutes (with possible participation of others) for deep seismic reflection profiling of the Bulgarian crust and lithosphere. This would provide a highly needed base for modern process-oriented research in the solid earth in Bulgaria. The geological expertise is essential for the interpretation of the geophysical data, and GPhI has a track record in seismology and data acquisition.

This applies especially to the field of geological hazards/risks: e.g. databases on historical seismicity and impact of past damaging earthquakes, with the Central Laboratory of Seismic Mechanics and Earthquake Engineering; landslides and related events, with GI.

The accumulated data on history of the Earth’s geomagnetic field should also be promoted at international level.

Institute of Oceanology (IO) - 504

Executive Summary

IO "Prof. Fridtjof Nansen" is a multidisciplinary research unit of the Bulgarian Academy of Science (BAS). Its scientific domain deals with marine sciences generally. Its research priorities are: Black Sea (BS) ecosystem assessment (including response to external forcing, including climatic changes); sustainable management of living and nonliving marine resources; marine geology and geomorphology and alternative energy resources; coastal zone dynamics and integrated coastal zone management; ocean technologies; GIS; operational oceanography; underwater investigations; deep sea archeology; modeling; forecasting; and risk assessment.

The total number of employees is 116 (average age: 47; gender balance: M/F=0.53). Among the 55 scientists, 17 are professors or associated professors, and 35 have a scientific degree (30 PhDs, 5 doctors in sciences); 11 PhD students contribute to the science programme.

Funding of research activity originates from BAS budget subsidy (40%), public bodies 10%), National Science fund (9%), international organisations (29%), industry (10%).

During the 5-year period of reference, *51 papers have been published in international peer-reviewed journals*. Total number of *citations* in specialized refereed journals amounts 510; this includes 302 for marine biology and ecology, and 110 for marine chemistry.

Examples of scientific *achievements* are listed as being: adaptation of operative wave models, construction of a paleogeographic model of the Black Sea for the period of 6000 BC, biodiversity changes and ecological status of the Black Sea, re-analysis of long-term trends in the plankton assembly and environmental data array (1960-2007), new bio chemical properties of the BS mussels.

International dimension: the IO is involved in a number of bilateral and multilateral co-operative actions, including numerous projects funded by the European Commission. IO has already co-ordinated international projects on the Black Sea at basin scale. The IO has organised and/or hosted international forums.

Critical points: aging of the staff, low attractiveness for young researchers, non flexible organisation and structures, lack of expertise in microbiology, marine genomics and in coupled, physical-biological modelling.

Prospective: already an active partner within the European Research Area, the IO's ambition is to become a marine centre of the Black Sea arena that has more visibility at international level. Scientific priorities have been internally identified as well as pragmatic solutions to the present difficulties and constraints that limit the growth of the Institute. Overall, the IO has a real potential to be competitive at the international level.

Summary Recommendations:

- ***Strategy***: the BAS should join the Marine Board of the European Science Foundation.

- ***Science***: the BAS should take the initiative of organising a Cluster of Excellence in marine sciences and resources for the Black Sea, in which the IO should play a pivotal role.
- ***Infrastructures***: urgent financial support from the BAS is needed for infrastructures and scientific equipment in chemistry, biology/ecology and operational oceanography as well as for the surface and submersible research vessels.
- ***Higher Education***: building a PhD network with key partners in marine sciences of the Black Sea area should be a high priority for the IO.
- ***Transfer of knowledge to industry***: It could be managed through a cluster that includes the economic, research and higher education stakeholders in the Bulgarian marine and maritime area, which are willing to combine and increase their capacity for innovation and are encouraged to lead R & D projects.
- ***Public outreach***: to be strengthened when possible and especially in cooperation with the Varna aquarium.

(a) Quality and productivity

Quality

Generally good quality, although more publications in peer-reviewed international journal would benefit IO visibility at the international level. Marine biology and ecology as well as marine chemistry already have some international recognition, as attested by high quality international journals, in which scientists of the IO used to publish their papers. A large part of the IO activity is related to applied research. However increasing involvement in EU-funded programmes is very helpful to maintain and develop the IO contribution to basic research.

Also, supported by a significant exchange of personnel with foreign marine institutes, the capacity of the IO to develop innovative research is quite large in different domains, which include physics, chemistry, biology and ecology, geology and archaeology, coastal zone dynamics and ocean technology.

Productivity

Currently, the scientific productivity is modest as attested by the small number of papers published in international journals: 51 for the period 2004-2008 (ie., less than one per scientist), compared to the 100 papers published in Bulgarian scientific journals. In addition, 77 papers have been published as contributions in congress and symposium proceedings.

However, IO has organised and/or has hosted a respectable number of international meetings and has continuous links with key marine institutes over Europe and beyond, which with bilateral or multilateral collaborations are developed.

Overall score for Quality and Productivity: "A", for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*" The IO is internationally acknowledged through participation in European/global programmes.

(b) Socio-economic Impact

The scientific activities of the IO, which are well documented in the Institute's website, are regionally oriented, with a particular focus to study the living and non-living resources of the Black Sea. Participation in programmes for the Black Sea sustainable management, funded by the EU, promise to be very helpful for the IO scientific growth.

Overall score for Socio-economic Impact: "*Highly relevant.*"

(c) Prospects

The IO ambition is to become a national marine centre well positioned internationally. The research priorities are:

- Black Sea Ecosystem assessment (physics, chemical and biological properties biodiversity and biogeochemical interactions, response to external forcing, including climatic changes),
- Sustainable management of living and nonliving marine resources,
- Marine geology and geomorphology and alternative energy resources
- Coastal zone dynamics and integrated coastal zone management
- Ocean technologies, GIS, operational oceanography, underwater investigations
- Deep sea archeology
- Modelling, forecasting and risk assessment

To build a modern and efficient Institute, the IO asks for more research funds to be used for replacing old equipment and facilities, and for attracting high quality junior or senior scientists. The IO also proposes financing mechanisms that are strictly bound to the research results. The prospects presented during the interview identify research priorities for the present and near future as well as pragmatic solutions to overcome difficulties and weaknesses and to propose pragmatic solutions to daily challenges. This effort was much appreciated by the Panel.

Overall score for Prospects: "*High.*"

Overall Strengths and Weaknesses

Strengths

Long history of contributions; expertise of the Black Sea oceanography and of its ecosystems and resources; since 1998 a regular seasonal complex monitoring on marine environment has been carried out which put the IO in a good position to enter a European infrastructure in operational oceanography; already existing bi- or multi-lateral links with key partners in marine science and technology over the world; increasing involvements in the building of the European Research Area.

Weaknesses

Small core of individual scientists; too little involvement in papers published in international peer-reviewed journals; the lack of expertise in microbiology and marine genomics as well as in coupled physical biological models is critical with respect to the Institute's ambition to focus on environmental, climatic change and sustainable development.

Recommendations

- To structure and strengthen the marine sciences at the national level the Academy should take the initiative of creating a Cluster of excellence in marine sciences and resources. This Cluster of excellence should include IO, the Institute of Fisheries and Aquaculture, and others groups from universities and/or from other institutions able to make significant advances in marine sciences. The first tasks of this cluster should be to prepare: (1) A science plan for the next 10 years. This science plan should identify the major scientific questions (basic and applied research) to be addressed in marine sciences at large in the context of the impacts of global change and of sustainable development. It should also include a strategic vision of the positioning of the member organisations of the Cluster of excellence in the Black Sea area and at the European and international level. Regarding the Black Sea area if the IO is to become a leading marine centre it needs a clear vision of co-operation/joint programming with other key institutes like the HCMR (Greece), the METU (Turkey), the Institute of Biology of the Southern Seas, and Marine Hydrophysical Institute (Ukraine), and Romanian marine research institutes/stations. (2) An implementation plan. It should identify the research infrastructures and facilities to be maintained or acquired during the next five years (also see the second bullet). Specific attention should be paid to the maintenance or renewal of surface and submersible research vessels and to operational means at sea for operational oceanography. It should also propose the creation of a Marine Data Centre to host and rescue the miscellaneous data accumulated in environmental studies since decades. The Science Advisory Council of this Cluster of Excellence could include external experts from major marine centres of excellence in Europe.
- If the IO is to maintain its position in the Black Sea arena, and is to develop its unique know-how, particularly in chemistry, in marine biology and ecology, and in operational oceanography, there is an urgent need for a strong plan to support infrastructures at national and regional level. At the regional level equipments located in Varna like nutrient autonalysers, CHN analyser, atomic absorption spectrophotometer, ICP-MS (HR and MC), Coulter Counter, Zooscan, computing facilities, etc… are urgently needed as well as training of personnel dedicated to these scientific equipments. Access to these facilities could be shared by the IO and other partners within a consortium.
- More attention should be paid by the IO to structuring the transfer of knowledge to industry and economy, and to a larger audience:
- The transfer of knowledge to industry and economy could be managed through a cluster that includes the economic, research and higher education stakeholders in the Bulgarian marine and maritime area, which are willing to combine and increase their capacity for innovation and are encouraged to lead R&D projects. The ambition should be to develop innovative products and services based on key technologies in order to achieve a competitive edge on national markets and beyond, and to create opportunities and jobs.
- The IO public outreach programme could be strengthened in cooperation with the Varna aquarium. This programme should include educational activities for young public, including pupils from colleges and high schools. This will help the Bulgarian citizens to discover and support the importance of research in marine sciences in the context of global change and sustainable development.

- To build a PhD network with key partners in marine sciences of the Black Sea area should be a high priority. This Doctoral network will contribute to improve the research capacity building for PhD students and to strengthen research networks in the Black Sea arena.
- If Bulgaria is to maintain and strengthen its position in the European Research Area, the Academy should become a member of the Marine Board of the European Science Foundation (MB-ESF).

Space Research Institute (SRI) - 505

Executive Summary

SRI, established in 1987 (though originating from the Group of Space Physics of the Presidium of the BAS from 1969), carries out fundamental and applied research in the fields of space physics, remote sensing of the earth, space technology, space biology and medicine and materials science within the Bulgarian Academy of Sciences (BAS).

SRI consists of 8 Scientific Departments: Space Physics; Remote Sensing of the Earth; Aerospace Control Systems; Astrophysics and Synergistics; Aerospace Engineering and Technologies; Space Materials Science and Nanotechnologies; Space Biotechnologies and Vacuum Studies; Aerospace Information Centre.

SRI has a distinguished heritage in Space Research dating back to the 1970s. It currently has considerable success and expertise in certain niche areas of astrophysics, space physics, remote sensing and space biotechnology. It also has competence in aspects of materials science and instrumentation and has had considerable success in selling its knowledge to commercial, governmental and military customers. However, it appears to operate to an extent on an ad-hoc basis without a realistic over-arching strategic vision of its scientific and technical goals. This is partly exacerbated by the fact that Bulgaria is not a member of ESA and does not have guaranteed access to a large space programme as used to be the case in the Soviet era. Furthermore, the relationship of the SRI with the Solar-Terrestrial Influences Laboratory does not seem entirely clear. In fact, the reason for the existence of 2 separate Institutes with a prime focus of space does not seem well-established except for historical reasons.

Other problem areas (in common with many other Institutes) exist including a modest publishing record (with some areas of exception), an uneven age distribution, difficulty in attracting sufficient young staff and low salaries.

Furthermore, the Institute is located at 4 main sites throughout Bulgaria – and even in Sofia, there are 5 separate locations. There were undoubtedly solid reasons in the past why this was so but a re-assessment is needed to see if it is the best structure for today and the future.

(a) Quality and productivity

Quality

The SRI has a long and illustrious history of space research with involvement stretching back to the relatively early days of space research, and encompassing the fields of space physics and space biological and life sciences amongst others. But these were mostly carried out in the "Soviet Era" when access to the Intercosmos and other programmes was relatively easy. With the changing geopolitical situation, such collaboration is not so easy. At present, involvement in major space activities is achieved on a more ad hoc basis. This reflects accordingly in a varied level of quality since regular involvement is not guaranteed.
Examples of academic achievements are (i) the energy deposition into the ionospheric cusp region using the first magnetically conjugated ionospheric and high-altitude observations; (ii) Investigation of the quasi-static electric field anomalies in the upper

ionosphere associated with the seismic activity during August-September 1981; (iii) Study of the impact of environmental parameters on the growth and development of higher plants, simulating space conditions; (iv) Study of the processes and phenomena related with the change in the electric potential of the modules on-board the International Space Station; (v) Analysis of the X-ray spectra obtained by data from NASA's Chandra Observatory.

The five most important results of an applied nature include a national telemedicine system, remote sensing techniques and materials technology. The academic achievements described seem somewhat "historical" in nature, mostly representing activities some years in the past rather than in more recent times.

Productivity

The total number of publications in journals (as opposed to conference and symposium proceedings) during the 5 years under consideration amounted to 183 or a mean of 37 publications per year. There were 75 publications in international journals and 108 in Bulgarian journals. The publications in the form of abstracts or proceedings of international congresses or symposia amounted to 463, those in Bulgarian publications accounting for 390 and those in international publications to 73.

There were a further 10 publications of books or chapter in books within and outside Bulgaria. In view of the number of members of staff (125, of which 78 are scientists), the number of publications in journals, as opposed to conference proceedings, does appear to be quite low.

Some areas (i.e. astrophysics) produce a reasonable number of papers in high impact factor journals. Some other areas are less productive in terms of papers but the function of those areas is sometimes different and their main purpose is to develop new instruments or techniques or to provide a commercial service so their output is not assessable by output of papers. They appear successful at least in qualitative terms, judged by the significant number of external customers in the private, government and military sectors and the Institute should be commended for this.

As far as scientific impact is concerned, there have certainly been niche areas of success. But the Panel believes one must question whether at present there is sufficient critical mass, and also whether the effort is applied in the most productive areas, to be able to make a significant impact.

During the period 2004-2008, 28 PhD students were trained in the Institute (of whom 25 were Bulgarian and 3 foreign), of whom 7 successfully presented their PhD theses.

Overall, the number of foreign visitors is reasonable but the Panel noted that more than 50% of all visits are from a single country (Russia). Staff members have undertaken a reasonable number of overseas visits though the "quality and productivity" of those visits is difficult to assess.

The involvement of staff members in international bodies does not seem as high as one might expect for an Institute of this size and status (see Appendix 10).

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field."*

(b) Socio-economic Impact

There seem to be a reasonably impressive interaction with state institutions (e.g. ministries) and regional bodies (e.g. municipalities). Also 14 "products" have been implemented in collaboration with industry and some 12 patents and licenses have been granted in the period. This suggests at very least a moderate degree of direct socio-economic impact. In fact, some of the activities are clearly highly relevant to military and industrial applications as such work is directly carried out for such customers. This is no doubt partly for the financial health of the Institute. But it is reasonable to ask if this is the best place for such work to be done. Should a Space Research Institute be carrying out activities as diverse as the repair of avionics and hydraulics for aircraft and helicopters, and the design and production of tools for stone grinding? Other alternatives could see a "spin off" company being formed to carry out such work or at least an "arms length" operation being established within the SRI.

Overall score for Socio-economic Impact: "*Moderately relevant*."

(c) Prospects

The SRI showed itself to be highly capable of producing space instruments of quality during the "golden years" of Bulgaria's space involvement in the 1970s, 1980s and 1990s when fairly regular access to the Soviet space programme was guaranteed. At that time, significant resources were made available to the Institute. But the global and national positions of the Institute have changed drastically since then. Accesses to space opportunities and relatively generous funding have both been greatly diminished. The SRI has evolved significantly to meet these challenges and should be applauded for so doing. But now is surely the time to take stock and decide what the best way ahead is. What was the best strategy for the difficult period of transition may not be the best strategy for the period of "stabilisation" and hopefully movement towards a space programme focussed on ESA and the EU. A further issue that needs to be carefully assessed for this future period is the relationship between the SRI and the Solar-Terrestrial Influences Laboratory. Formed as an "offshoot" from SRI some 20 years ago, the issue of whether 2 Institutes who both have space as their prime raison d'être is one that can reasonably be questioned

There can be little doubt that space will play a leading role in scientific research both as a subject of study in itself and as a tool. The SRI has already shown itself more than capable of playing a leading part. But exactly what part must be better defined and elucidated. What should the balance be between a provider of instruments and techniques at one extreme and a user and interpreter of data from space at the other? This is a very wide spectrum and the position on that spectrum needs to be better defined. The Panel has no doubt that the SRI is very capable of playing the part that is demanded of it but the complexity of the subject and the resources needed require that very clear strategic planning be undertaken.

SRI recognises that its future potential in space research activities is very much impeded, inter alia, by the fact that Bulgaria is not yet a member of the European Space Agency (ESA). To this end, Bulgaria is negotiating to join the ESA PECS (Plan for European Cooperation States) – this must surely be applauded and followed through with vigour at Governmental level as a stepping stone towards ESA membership.

However a major issue that needs to be addressed critically is the overall programme of the SRI, its scope and extent. This is essential for the long-term perspective of SRI. Currently, the programme of SRI is in 8 broad areas corresponding to the 8 scientific departments. These areas are extremely broad, extending from some very "pure" science, in areas such as x-ray astronomy, through areas of both scientific and applied relevance (e.g. Earth's ionosphere, and space biotechnology, etc) through to very applied areas such as aerospace engineering and technology & aerospace control systems. This is an enormous range of disciplines and the Panel wonders if it is now the most appropriate to be followed by such a medium-sized Institute. The range of disciplines followed is probably a reflection of the historical strengths of the Institute and some more recent additions. But a strategic approach is necessary to ensure that the subjects to be pursued by the Institute make best use of the Institute's resources, are best matched to national needs and also well matched to ESA's long term plans. These are complex matters and it is not easy to satisfy these complicated and sometimes competing needs. But it is an issue that needs to be addressed.

Further issues that have a critical influence on the long-term perspectives of the Institute have been identified in the Self-Evaluation Report and include the age structure of the Institute (skewed towards elderly staff), lack of attraction for scientists to enter the Institute and an ageing equipment infrastructure. The age distribution of staff in particular (there are 19 members over the age of 55 and only 15 under the age of 35!) is an issue, which may compromise the ability of the Institute to exploit in the most efficient way future opportunities (especially in the space arena where some projects have a rather long time span).

Overall score for Prospects: "*Moderate.*"

Overall Strengths and Weaknesses

Strengths:

The SRI has shown great versatility in meeting recent challenges, using its long-established space expertise both in its "traditional" areas of interest but also by adapting to meet certain "market needs" (commercial & military). It has also shown itself well capable of fruitful interactions with National & Municipal bodies.

Weaknesses:

However, the lack of "guaranteed" space opportunities as Bulgaria is not a member of ESA has led to a programme that seems to be driven more by opportunism than by a strategic view of the direction ahead. Although this is understandable, it is not really desirable and has led to some dilution of capabilities. The success in more market-driven applications may also be weakening some of the more scientific activities. Also the existence for two major space research-related Institutes, while understandable from a historical perspective, may not be the optimum way to proceed for the future. There are other issues that are common to several of the BAS Institutes and need to be addressed - these include the age distribution, the publication record and an ageing equipment infrastructure.

Overall score

SRI has international standing in particular due to its historic activities in Space research. Currently, it is also engaged in a range of commercially driven activities, which have to some extent changed the focus of the Institute. The prospects for the future are more uncertain and depends, to some extent, on Bulgaria's possible future membership of the European Space Agency.

Recommendations

- Establish (with appropriate Ministry/government department) a timetable for accession to the European Space Agency
- Develop an overarching strategic plan for SRI particularly addressing which scientific and technological area should be pursued (and, as important, which areas should be dropped)
- Assess the overall commercial capabilities of the Institute, how these capabilities should be pursued and the best vehicle through which they should be pursued (e.g. spin-out company, "arms-length" commercial entity, etc)
- Critically consider the inter-relationship with the Solar-Terrestrial Influences Laboratory vis-à-vis the full range of space activities and produce a plan for rationalisation of responsibilities and activities. Is it appropriate in the current (international) context to have two major space research-related Institutes?
- Produce a publication plan with targets for all appropriate staff
- Propose a scheme to address the current imbalanced age distribution of staff
- Review the function and inter-relationships of the geographically distributed components of the Institute
- Generate an inventory of major existing equipment and future needs. Investigate the possibility of sharing the procurement, maintenance and use of major equipment with other Institutes

Institute of Water Problems (IWP) - 506

Executive Summary

IWP is an autonomous research unit of BAS, created in 1962. Its mission is to create and develop the theoretical basis and the applied tools for sustainable use of the water resources of Bulgaria and to assist the water governing bodies through seeking solutions to complex problems of the integrated water management. Its main research fields are: planning and management of water resources utilization; water resources quality management and water and wastewater treatment; hydraulic problems of surface and ground water systems; stability and strength of hydraulic structures; mitigation measures related to floods and coast protection against erosion. These research fields fit within the EU FP7 priorities areas regarding climate change, pollution, and risks, sustainable management of resources and environmental technologies. They also fit with the Bulgarian research priorities on ecology, biodiversity and biological resources, sustainable development, rational and efficient use of natural resources and science – basic drivers for development of knowledge-based economy and society.

IWP comprises 77 staff members including 41 researchers, 25 research supporting staff, 7 in administrative staff and 4 laborers. There are 4 Professors, 19 Associate Professors and 18 Researchers. The IWP is structured around 4 departments: Water Resources Management, Quality of Water Resources, Hydraulic Problems of Water Systems, Hydraulic Structures Stability, and five laboratories that are affiliated to them.

Examples of academic achievements: the development of a methodology for evaluation of water resource balances and water adequacy assessment of the water users and flood risks assessment; the evaluation of breaking wave impact on vertical and near-vertical parts of hydraulic structures. The IWP also developed a combined numerical model for computation of stress and strain state of gravity dams under the effects of static, dynamic and thermal loads and also a method for probabilistic assessment of the water user's supply reliability in limited future period with design and management of water resource systems.

Prospective: In the context of climate change studies, the Institute plans to focus more on developing tools for a sustainable water management in Bulgaria. This leads to the development of projects related to the evaluation of the water resources, the modeling of hydrological models for drought and flood prediction purpose and tools for reservoir use optimization in a multi-usage context.

(a) Quality and productivity

Quality

Most of the publications of the Institute are in Bulgarian journals (72) and therefore international recognition is low (84 citations for 13 papers) despite a fair amount of participation in international congresses (53) and visits of foreign scientists (84 from 9 different countries) to IWP. This situation seems to be due to the fact that the Institute research is applied and that publication in foreign journals was not the priority in the past.

Productivity

The productivity is fair according to the number of publications produced and the projects acquired. 37 out of 45 projects are financed by BAS or the Bulgarian Ministry of Environment. There is very little participation in international projects.

Overall score for Quality and Productivity: "C", for "*work that is solid and has added to our understanding and is in principle worthy of continuation. The Institute is nationally visible.*"

(b) Socio-economic Impact

The socio-economic impact and relevance is good with interesting applied projects such as the water use schemes and water resource balances of Ogosta, Kamchia, Tundja and Struma River basins in Bulgaria or a prototype of web-based Decision Support System (DSS) for integrated water management of trans-boundary catchments. The development of a methodology for nutrient elements balances in river catchments using GIS-based mathematical models has been also achieved. Application of hydraulic research is important and leads to development of new irrigation devices or water fountains.

Overall score for Socio-economic Impact: "*Moderately relevant.*"

(c) Prospects

The IWP understands the need for a change in its strategy and has correctly identified the areas where the Institute should focus its efforts in the near future. Indeed, water "problems" are expected to increase in the future. Therefore the collective scientific expertise of the Institute is very relevant. Yet, there is a need to be more strategic and structure the list of objectives and ways to achieve them. Moreover there is a need to reflect on the internal organization of the research process to open space for a more opportunistic approach to generate income and collaborations both nationally and internationally. The publication strategy does not seem to evolve significantly if the main results of research projects are published by preference in the Institute's journal.

Overall score for Prospects: "*Moderate.*"

Overall Strengths and Weaknesses

Strengths:

The IWP has an original position in the BAS context, as it is the only Institute that clearly addresses engineering issues related to water management. Yet, several other institutions in Bulgaria (e.g. NIMH, Institute of Geography, Central Laboratory of Ecology) and abroad are also addressing water management issues one way or the other. IWP is driven by a problem-solving approach and has already demonstrated several interesting applications. It has very valuable staff resources that combine interesting scientific and applied skills. There are also some interesting potential developments along the line of sustainable management of water.

Weaknesses:

The Institute suffers from a lack of recruitment and an aging scientific community.

Recommendations

Some recommendations can be formulated to ensure that the Institute grasps the opportunity to develop a well-recognized position in water management at both national and international levels.

- The IWP has the opportunity of having well-trained scientists in different fields related to water management issues. An internal forward-looking exercise could help formulate the uniqueness of the scientific consortium as a whole in the national and international context.
- The research strategy should be revisited to open up more opportunities, probably through national and international collaborations in order to compensate for the shortage of human resources.
- A problem-solving approach is a fully acceptable strategy as it is highly relevant to fulfill society's demand. Yet, the main drawback of such strategy is that the Institute cannot easily control its future scientific direction. A clear formulation of its strengths could allow focusing mainly on these specific issues and reallocating its scientific capacities to increase its competitiveness.
- In particular aspects, e.g. hydraulics, the IWP offers a continuum between fundamental and applied research. Indeed, many applied outputs of the Institute had required some original scientific research, which should be better advertised by being published in international, peer-reviewed journals.
- This more aggressive publication strategy should allow a better promotion of the research outputs of the Institute and foster international collaboration to compete for large international research grants. This international strategy would provide a more balanced funding income, which could buffer unpredictable national governmental requests.
- The knowledge transfer notably for hydrometrical devices flow and water level meters as well as the water fountains is remarkable. It could be developed further by creating a commercial company to fully exploit the benefit of these original technologies.
- Increasing the collaboration within the Bulgarian Academy of Science and the Universities researchers would help gathering a critical mass to develop further particular objectives.
- Some effort could be made to increase teaching in Bulgarian Universities or Engineering Schools in order to form and attract more young scientists in this field of research.
- Given the applied nature of the output of most research undertaken in the IWP it could be easy to improve the dissemination the results and the public awareness on water management issues.
- The English translation of the name of the Institute might be changed to fully address the water management aspects undertaken by the Institute (e.g. Institute of Water Management)

Institute of Geography (IGeogr.) - 507

Executive Summary

IGeogr. activities focus on implications of global change for the protection of Bulgaria's natural and human capital, sustainable regional development and training of young scientists and raising the quality of geographic education:

- Dynamics of the natural systems undergoing global changes from the viewpoint of the sustainable development of the territory of the country. It also includes research on alternative energy sources and balanced resource use, as well as risk processes and phenomena of natural and anthropogenic origin.
- Bulgaria's dynamic geographic situation, including its geo-strategic position in view of EU integration and participation in the Union's regional cooperation programs. It is supported by competences in solving national, regional, and local demographic issues, territorial aspects of social inequality, settlement system problems, economic specialization, infrastructure, tourism, trans-border cooperation, and regional development.
- Education and training.

There are 42 staff members, including 30 Research Fellows. The Institute is structured on 3 units: Physical Geography with a total of 12 researchers, including 9 Senior and 3 Junior Researchers; Economic and Social Geography with a total of 12 researchers, including 5 Senior and 7 Junior Researchers; Geo-informatics Center with a total of 6 researchers, including two Senior and 4 Junior Researchers.

Examples of academic achievements presented to the Panel are: the determination of threshold values to recognize the demographic crisis in Bulgaria; the development of a system of indicators for assessment of natural hazards risk, as well as for evaluation of the vulnerability of a given area. The Institute also built up a classification of the climate-recreation approaches for evaluation of the Universal Thermal Climate Index, which opens new application in the recreational climatology sphere in Bulgaria. The Institute also developed the theoretical foundations for the formation of landscape parks and geo-parks as a new form of rational use of the natural resources and sustainable tourism, as well as zones for adaptive resources use.

Prospective: The research plan of IGeogr. will focus on three larger themes, i.e. Global Changes and Environmental Protection; Sustainable regional development, euro-integration and trans-boundary cooperation; and Education and Training. The latest theme will be supported by the fact that the Institute became a member of the European Network for University Geographical Education HERODOT in 2008. Each theme incorporates several interrelated scientific programmes. These programmes will be realized through their already funded research projects, creation of databases, publication of articles and books, as well as through preparation of research proposals and seeking of external funding.

(a) Quality and productivity

Quality

The total number of publications for the 2004-2008 period is 472 and their number rose from 64 in 2004 to 143 in 2008. Almost 39% of them are published in refereed journals, 32% in conference proceedings, 2% are books and textbooks and the rest are popular science publications. About 23% of the research publications of the Institute are published abroad, including 14 books and 30 publications in international refereed journals. The publication quality could be improved by targeting on more international peer reviewed journals. The researchers from the Institute are cited in 419 publications in this period, 169 of them abroad. The Institute has several international collaborations in Europe and elsewhere, which are materialized by project cooperation's. The Institute has developed a very informative web page.

Productivity

In the period considered, the Institute has worked on a total of 46 joint international research projects and 61 national ones. Seventeen of them are in the framework of the Academy's bilateral agreements, predominantly with EU countries (7), as well as Serbia, USA, Russia and Turkey. They paid a total of 72 visits to foreign research institutions to participate in workshops and seminars and presented a total of 38 research papers.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

(b) Socio-economic Impact

A very significant share of the research activities at the Institute consists of projects with application in the areas of environmental management, state administration, education, tourism, as well as projects solving very concrete problems. The projects, which concern sustainable environmental management, are mainly in the areas of landscape ecology, risk assessment and management, land use, and protected areas.

The excellent inter-institutional partnerships and the inter-disciplinary approach are crucial for the successful implementation of the geo-information technologies used in these projects. In that respect, IGeogr maintains numerous partnerships with other BAS Institutes: It has cooperation agreements with the Central Laboratory of Geodesy for collaborative use of the *Observatory of Geodesy "Plana"*, the Institute of Nuclear Research and Nuclear Energy for joint research in the *Base Ecological Observatory "Musala*", SRI to establish a *Technological Transfer Office*, financed by PHARE, and the Solar-Terrestrial Influences Laboratory to build and use the facilities of the Geo-informatics Center. The longest collaboration IGeogr maintains with SRI and particularly its *Remote Sensing department*. For the 2004-08 period, researchers from the two Institutes complemented each other on seven interdisciplinary research projects. The perspectives of continuing this interdisciplinary collaboration are even better, due to the newly created Geo-informatics Center.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

The research perspective generally reflects the topics of the projects, on which the Institute worked during the last period, and for which it has built the necessary research capacity. A very clear vision was presented to the Panel about the future of the Institute and how to achieve the Institute's goals, which are shared by the staff members. The

nature of the "real-life" problems tackled corresponds to the research programs of a very broad spectrum of Academy's units and necessitates application of interdisciplinary approaches in almost every case. The scholars with the necessary competencies are free to join the flexible work team(s) organized within a particular programme, irrespective of the actual administrative unit they are listed with. The management expectations are that this organization of the research work should contribute to more flexible and efficient a realization of the relatively small number of scholars at the Institute, the development of the capacity to work on problems of priority to contemporary society, taking the development of scientific cooperation with international and national institutions, and particularly the private sector to a new level.

Overall score for Prospects: "*High.*"

Overall Strengths and Weaknesses

Strengths:

The Institute has adopted a clear strategy to develop its projects further at the interface of several disciplines and has successfully found collaborations, first in Bulgaria within the Academy of Sciences but also at the University, and second, abroad to palliate its relatively small staff team. There is a clear vision for the further development of the Institute, which is shared by the staff. The creation of a centre of geo-informatics is a key structural element for the cohesion of the Institute and its way forward in interdisciplinary research development and output.
The research process at IGeogr. is organized on the "project" principle. Teams form freely on a basis of the interests and areas of specialization of the individual researcher. This creates a very positive and active mechanism to develop projects and seek grants. The Institute seems to be in a very positive and dynamic phase, being able to develop several interdisciplinary projects, both in Bulgaria and internationally, due to its range of competence at the cross road of many disciplines from physical to human sciences.
There is a great effort in teaching matters, as it is one of the 3 main objectives of the Institute. The staff is well implicated in teaching with more than 4000 hours in 5 different institutions. They also have produced 4 university text books. This is a very good development strategy.

Weaknesses:

The main issue of concern to the Panel is the relatively small number of staff, especially when developing so many collaborations. Moreover the staff members are relatively old with 9 researchers between 51 and 60 years old and 6 between 30 and 35 years old. Moreover, there is not enough recruitment to secure the viability of the Institute in the next 10 years. Another weakness is related to the small number of scientific publication in international peer reviewed journals, especially in the field of physical geography.

Recommendations

Some recommendations can be formulated to ensure that the Institute grasps the great opportunity to develop a leading position at the interface between physical and social sciences:

- The originality of the Institute as a whole is its capacity to address interdisciplinary questions related to global change and regional sustainable development; but in

order to do so, its has to rely on strong disciplinary scientific foundations both in physical and social sciences. Therefore, both departments of Physical Geography and of Economic and Social Geography should strengthen their disciplinary visibility, maybe through collaboration with other disciplinary institutes such as geological, geophysical or economics institutes.

- This comment is also true for the recently created centre of Geo-informatics, which should gain international recognition by developing its own scientific agenda in spatial analysis and modelling. The existing collaboration with the Geo-informatics Centre from the Solar-Terrestrial Influences Laboratory is very welcome to achieve this goal.
- The applied projects developed in the Institute are very interesting and provide clear evidence of the societal importance of the research implemented. Yet, although this applied research is often supported by theoretical concepts and original methods, their publication in international peer-reviewed journals is too low. Therefore, there is a need to reflect on a more systematic mechanism to conceptualize the existing know-how and publish it in relevant international journals.
- The creation of a new Geo-Demography Department that was presented during the visit is very relevant because it would open many opportunities to develop realistic scenarios of land use and land cover changes in the context of global change and regional sustainable development. This could be achieved by seeking collaboration e.g. with the BAS Center for Population Research, and attracting more young and senior scientists in this scientific domain.
- The edition of the scientific journal “Problems in Geography” is a laudable endeavor, but in the current context, it should not be done at the cost of the priority that is to publish in leading international peer-reviewed journals. The objective of this journal could be reconsidered as a communication tool to promote geography within the Bulgarian authorities and population. This would complement the remarkable ongoing trans-disciplinarity efforts of the Institute.

Central Laboratory of Geodesy (CLG) - 508

Executive Summary

CLG, established in 1948, is a relatively small, specialized BAS scientific centre for theoretical and applied geodesy. Its scientific domain covers the study of the earth as a planet and its physical fields and expert activity in the area of geodesy on the territory of Bulgaria. To carry out its national tasks in the field of geodesy and cartography, the CLG collaborates with the Ministry of Defence, the Ministry of Regional Development and Public Works and the Cartographic Agency. In addition, CLG has the responsibility of the Plana Geodetic Observatory. This observatory is an example for inter-academic cooperation as well as cooperation with different universities. Its partners from BAS are GPhI, IGeogr., Central Laboratory of Seismic Mechanics and Engineering and Central Laboratory of General Ecology. At the university level there exist contracts with the departments of physics and astronomy of the University of Sofia.

In total, the CLG employs 19 scientists (of whom 5 are part-time). They are supported by 10 engineer-specialists (of which 5 part-time): 4 of them are allocated to the Plana Geodetic Observatory as observers or person in charge, while the others are mainly in support of electronics, mathematics or informatics.

The governing body consists of a director, deputy director and scientific secretary, chairman of the Scientific Council, chairman of the General Assembly and 3 head of departments (Problem Groups). These 7 posts are taken by 5 professors only as one of them is Deputy Director, Chairman of the Scientific Council and Head of the Second Group at the same time. In addition to their governing duties, these 5 professors belong to the research staff of the CLG.

The evaluation shows that the CLG has an important mission and hosts some highly specialized knowledge. However, in order to fulfil its task within BAS as a centre of creative research, it requires restructuring and should obtain a larger critical mass. Integration of the CLG within a larger Institute might be a solution.

(a) Quality and productivity

By decree of the Council of Ministers of the Republic of Bulgaria a number of important tasks are assigned to the CLG such as the processing and analysis of the results from the measurements of the State Reference Networks (GPS and gravimetric network and State Levelling Networks), support for the operation of the tide gauge stations and analysis of the Black Sea level. The output from the CLG is therefore substantial by serving the general public and the infrastructure of the country by providing a modern precise National Geodetic Net work (GPS and State Levelling Network) and integrating it within European and global networks. As centre for the analysis of laser ranging of artificial earth satellites of the 'International Earth Rotation Service' and as associated analysis centre of the 'International Laser Ranging Service' it contributed with success to the monitoring and updating of the ITRS (International Terrestrial Reference System) and of the earth rotation in space. It established a network of permanent Global Navigation Satellite System (GNSS) stations. The CLG has also carried out a number of geotectonic studies mainly in South West Bulgaria and contributed to the time series analysis of sea level of both the Atlantic Ocean and the Black Sea. A model of the average sea level of the Black Sea and Aegean Sea was obtained from the altimetric data from a number of

satellites (ERS, TOPEX/Poseidon). Since 1983, the CLG has also been responsible for the operation of the PLANA astronomical and geophysical observatory and contributes every year to the publication of the Astronomical Almanac. The educational activities of the unit are substantial and focus on geodesy, satellite geodesy, GIS technology and surveying. In the period 2004-2008, 7 PhD students were trained at the CLG. A relative success as recruitment of PhD students is a serious problem due to the low bursaries.

The research is organized in three so called 'Problem Groups': Group 1 (Theory of the earth's figure) including 2 professors and 2 research associates; Group 2 (Methods of classical and satellite geodesy) including 7 professors, 2 research associates and 2 engineers; Group 3 (Global navigation satellite systems in geodesy) including 2 professors and 3 research associates. The critical mass might be too low as there are insufficient personnel for terrain measurements, processing and analysis of data and a need for young scientists. It appears both from the interviews and from the self-evaluation report that this organisation structure in three problem groups is unbalanced with respect to the number of staff, competence and leadership, while also the threefold subdivision and associated tasks were questioned.

The number of publications during the last 5 years range between 27 and 51 per year. With the highest number of publications, i.e. 45 and 51 publications in 2006 and 2008 respectively there seems to be a tendency to increase output. The total number of international publications over the last 5 years is 15 and they have occurred only since 2006. This poor result gets worse if one considers peer reviewed international publications (only 7). The publications in the form of abstracts or proceedings of meetings amount to 20 over the last 5 years, with a remarkable lack of such publications in 2008!

Some 53 research projects were carried out in the period 2004-2008, most of them by Problem Group 2 (Methods of classical and satellite geodesy). Many projects were financed by the BAS budget subsidies. There was however also substantial external financing by the Bulgarian National Science Fund (13) and 15 projects were possible due to bilateral contracts or mutual exchange with international institutes. There was 1 project financially supported by the EU FP5 and 1 project financially supported by the NATO 'Science for Peace' Programme.

Overall score for Quality and Productivity: "B", for "*Work that is internationally visible. The Institute has made valuable international contributions in the field.*"

(b) Socio-economic Impact

The scientific support for the establishment of a National Geodetic Network and for the integration of this Network within a broader European or Global one is highly relevant for mapping and civil engineering purposes, military activities etc. .Moreover the gravimetric, levelling and GPS data provided by the CLG are fundamental in understanding the crustal dynamics in a country prone to seismic hazards and land slides, while modelling the Black Sea level is a key issue in the regional global warming scenario's.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

When the Institute's national and international obligations (national geodetic network, European and global reference systems) are taken into account, future efforts will be focused on continuing these tasks and hopefully extending the current scientific topics. Indeed, in the field of geodynamics some good international cooperation with leading institutes in the USA, Europe and NATO have been established in the past but tapers off for the moment. Increasing the role of the Institute in solving national priorities and increasing its scientific output can only be achieved by restructuring its internal organization, attracting young people, increasing the number of personnel and drastically changing the publication strategy.

Overall score for Prospects: "*Moderate.*"

Overall Strengths and Weaknesses

The CLG fulfils its task for society and its national and international obligations. The accession of the Republic of Bulgaria to the European Union was realized with a modern National Geodetic Network as a part of the European coordinate system. The Bulgarian authorities cannot cope without the specialized expertise of the CLG. The Institute is therefore nationally and - also in part - internationally visible.

The Institute fails however in one of the strategic goals of the BAS, i.e. to become an 'engine of knowledge-based society' due to the lack of fundamental research and international scientific output. The best scientific output is achieved in the field of geodynamics, where both international collaboration and cooperation with other BAS Institutes (GPhI and GI) was established.

Strengths:

- Highly specialized knowledge
- Good integration in international networks
- Some good collaborations with other BAS Institutes
- Fulfils its national obligations
- Good education outreach

Weaknesses:

- Small Institute, insufficient critical mass
- Unbalanced organization structure
- Unfavourable age structure of staff
- Lack of internal communication, seminars, foreign visitors, international student exchange
- Deficit of peer reviewed international publications
- Inadequate publication strategy.

Recommendations

The basic efforts in future should be focused on continuing and extending the present scientific topics, as the CLG carries out important activities for the economic and infrastructural development of Bulgaria. In view of the international umbrella under which practical all geodetic activities take place, the international collaboration is more

or less warranted but must be strengthened. Contacts and contracts with private companies must be expanded.

In order to achieve this it appears absolutely necessary to restructure the 'problem scientific groups'. Problem Group 1 ('Theory of the earth's figure') has a markedly low publication output. It might be necessary to reshuffle tasks and staffing between the present groups. Ranking and promotion of personnel should occur according to both scientific and organisational merits. The problem group leaders should be those with the highest experience and international contacts. Internal meetings, reports and seminars should be organized. The Institute needs restructuring in function of both societal obligations and scientific outputs.

Eventually the integration of the Institute in a larger one (GPhI) should be considered. The publication strategy should be altered with absolute requirement of international, peer-reviewed publications. The relevance of the CLG to produce its own 'Geodesy Journal', based on a staff of 19 scientists and on a modest reader potential, is questioned.

Central Laboratory of Mineralogy & Crystallography (CLMC) - 509

Executive Summary

CLMC has many assets: well-developed international co-operation; expertise in running complex analytical techniques; openness toward national needs in matters of materials' analyses; significant publication records. The main issue to be addressed and resolved in the near future is how to keep developing further analytical services and, at the same time, make the basic research activities converge toward an overall scientific programme agreed upon by the active CLMC's research teams; a solution to this issue will help to attract more young professionals, more interested in either basic science or in getting advanced professional training/experience in analytical skills.

(a) Quality and productivity

Quality

CLMC has an excellent team under young and dynamic leadership. The team has been successful in counteracting the brain-drain of young scientists, by attracting gifted young Bulgarian researchers from abroad. Four Humboldt Fellowships have been awarded to members of the team.

Achievements of 3 PhD-awarded outstanding students and of 5 PhD students are remarkable and a series of scientific topics have been worked out in the past few years, at the highest level.

The total number of positions opened at CLMC (55) makes it a middle-sized Institute and more than 1/10 are reported "administration positions" (6); it is not clear what the "subsidiary division" is; if aggregated to "administration", the latter jumps up to ¼ of the total work-force of the Central Laboratory. The age distribution is given for 44 staff members, i.e. more than the positions distributed among the scientific/technical departments of the CLMC (40), but less than the Central Laboratory's total staff: it makes it difficult to interpret; yet, the striking feature is that the peak of the distribution is in the range 46-50, with a marked skewness toward higher ages; the reverse would be much more favourable for the Central Laboratory as a whole; yet the overall situation is not bad, provided that, in the near future, opportunities of hiring young scientists make it possible to complement and/or replace the work capacity of the Institute. A finer comparative analysis bearing on the age distribution of researchers strongly engaged in co-operation abroad, and those remaining "at home", is needed for a better appraisal of the problems and before hiring new staff.

Some scientists at CLMC are involved in the overall life of the discipline; in particular in the review of papers submitted to scientific journals. It could be wise to concentrate (partially) on "in-house" original science.

Some information was given on the analytical instruments currently available (transmission electronic microscope, crystal X-ray diffractometer, FT-IR spectrometer, ...), supplemented by the Panel's visit to the Institute: all those "old" instruments have been carefully maintained and kept productive for many years, much more than the life duration usually expected; at the same time, the physical environment of the

instruments has obviously not benefited from the same care and some new pieces of equipment (like the scanning electron microscope) will require much better attention as for their physical environment. The same holds, mutatis mutandis, for the new equipment they aim to obtain (like the laser-abrasion mass-spectrometer); the idea of setting up a consortium with other organizations (within and/or outside the BAS) to buy an expensive piece of equipment is very much welcome and should be firmly encouraged and will, no doubt, prove effective; the conditions, both in the conditions of the personnel and physical environment, for properly accommodating the newly acquired instrument should be seriously considered..

Productivity

Overall scientific activity at CLMC, as measured through publications, is quite impressive; they publish in high-quality peer-reviewed international journals; a possibly major weakness comes from the large amount of activity actually performed in institutions abroad since quite a few productive scientists (in terms of researcher-months) are very often away from the Central Laboratory; this is fine per se, but the obvious danger is a rampant brain-drain. Nevertheless, it became apparent during the visit and through the discussions that this possible adverse effect was more or less under control, as far as feasible; in particular, quite often CLMC's scientists are first authors of common publications. A tendency to be kept under strict control regarding the "opportunity" of publishing after having performed ordered analytical work is another potential danger; the analysts involved are entitled to be included in the list of authors of any publication drawing upon the analytical results obtained, but not necessarily among the leading authors; this does not seem to raise problems in the present situation in which the initiative of investigating the topics remains essentially in the hands of the scientists. Anyway, CLMC's scientists should be permanently encouraged to publish their results in worldwide-renowned scientific journals.

161 papers mostly in prominent international journals are reported over 5 years. The most striking feature is the extreme variety of subjects, from Mineralogy/Geology sensu stricto, to coal combustion products, or dental matter. Most probably, many should be regarded as the (sometimes long-term) outcome of visits to foreign labs; this interpretation is supported by comparing the list of publications in "scientific journals abroad" (161 referred articles) and the list of publications in "scientific journals in Bulgaria" (84); the ratio is 2/1, whereas one would have a priori expected the reverse: this is a good asset; it is further featured by the average numbers of authors per paper: 4.03 for publications abroad as compared to 2.76 for publications in Bulgaria. Most probably, Bulgarian authors aggregate research teams already established while abroad. CLMC's researchers actively look toward foreign-institutions for co-operation, at least for some of the topics investigated.

There is limited transfer of knowledge from CLMC to "clients": CLMC acts as a simple-commerce service provider, especially when performing straightforward analyses. The intellectual benefit of such operations for CLMC is unclear. Initiatives at investigating specific topics are most often taken by the CLMC's researchers on scientific grounds; a further step, still to be achieved, is to try to attract the interest of potential users in the results obtained.

Overall, this Institute is composed of a highly motivated research team with a young and dynamic leadership and its holds a strong potential for excellent research in the near

future, also in view of its demonstrated capability to attract outstanding young scientists and funding for new equipment and infrastructure.

Overall score for Quality and Productivity: "A", for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

(b) Socio-economic Impact

Obviously, the domain of activity of CLMC is highly relevant for Bulgaria; the importance of mineral resources in the country would be a sufficient justification.

On a more general background, many scientists are reported as having participated in teaching activities: a significant number of teaching hours are reported (889 + 1361 hrs. over the 5-year period). This looks a priori very good, but scientists, devoting too much time for teaching without a significant number of bachelor and master degrees awarded, are expected to not have enough time for research activities.

A clear bias appears, in international research projects, in favour of former "eastern European block"; it is straightforward as long as BAS is officially a party in, as it allows co-operation with very limited currency implications; for other co-operation projects, apparent bias is significantly attenuated in other context: the contacts with scientists from western European countries are quite developed.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

Impressive professional skills are currently available at CLMC. The Institute has many ideas for further developments both in topics to be investigated and in increased analytical capabilities. The personnel's age structure is not unfavourable. The Institute's management is decidedly oriented toward enhanced co-operation, both among the BAS Institutes and with other organizations. The outlook is very good for CLMC; efforts for further integration with other BAS Institutes programmes should be encouraged.

The main problem of CLMC lies in the personnel issue, apart from the overall age distribution:

i) It is noticeable that only one "senior research fellow Degree I" shows up in the personnel list of the Central Laboratory; only two Dr.Sc. are in the staff;

ii) Because of the extremely focused research topics and the necessity of advanced analytical resources, but also because of the demand from outside, an obvious tendency to extroversion prevails over introversion with respect to CLMC, if one disregards the "Service Laboratory Department" for which activity is naturally strongly related to the service of "clients" in the broadest sense). The corollary is that this extroversion leads to impressive CLMC co-operation records. On the other hand, better introversion would automatically lead to more CLMC "endogenous" basic science being developed. This is clearly a matter of policy within CLMC, and BAS of course;

iii) The prevailing extroversion underlined above explains partly why finally overall-limited student training takes place within CLMC, although there could be also some

structural reasons as well, such as the widespread problem of scarce remuneration in the public-domain research sector. Nevertheless, getting higher education skills, even though one knows that the professional career will not develop within a definite-scientific environment, could still remain attractive, especially in the domain where students would at least gain professional experience by using high-tech equipment and advanced work methods. Anyway; activity better centred on "in house" basic science topics would help CLMC attracting, for a definite duration at least, more PhD students. Actually, the Laboratory puts a major emphasis on human resources.

Overall score for Prospects: "*High.*"

Overall Strengths and Weaknesses

Strengths:

The main strengths of CLMC are professionalism (in particular, in mastering advanced, sophisticated analytical instruments); openness to co-operation, inside and outside BAS; numerous contacts with the economic world, at least within Bulgaria; good insertion in the worldwide community (co-operations, mutual working visits, publications in common).

Weaknesses:

The main weaknesses are dispersion (from solid-state physics to "applied-geology" mineralogy [ore deposits]), not enough clear focus on "in house" research lines and difficulties in hiring young scientists.

Recommendations

The main recommendation is to have a clearly stated science policy for the Institute. Having many research fellows working on many different topics under co-operation schemes and involving many domestic and/or foreign institutions does not make up a science policy. It is important that the Laboratory maintain a definite priority on quality.

The team has been very pro-active in the successful acquisition of new instruments in consortia with other BAS Institutes: this should be further encouraged.

The opportunity of keeping under CLMC the traditional wide range of sub-domains historically grouped under "Mineralogy and Crystallography" (or even further including "materials science"), must be investigated and addressed. The same holds about whether to develop further analytical services oriented toward the "analyses market", academic and/or industrial, or to remain an Institute mainly oriented toward "in house"-defined basic research activity in the Earth's sciences.

In this context, the Panel endorses the ambition of the Laboratory to establish a "centre of excellence" in mineralogy, crystallography and material science.

Solar-Terrestrial Influences Laboratory (STIL) - 510

Executive Summary

STIL was founded in 1990 by the Management Council of the BAS and today carries out "fundamental space research and its application in solar-terrestrial physics, in-situ and remote investigation of the geospace, planets and interplanetary space, study of global change and ecosystems and heliobiology and telemedicine/eHealth".

The STIL organizational chart shows a division into 4 Departments: Remote sensing of Earth and planets; Geoinformatics; Solar-Terrestrial Physics & Heliobiology and eHealth; and Optical atmospheric investigations. However, it is stated that this structure has become too rigid and that the Institute is now organized around 9 thematic groups, which are claimed to be closely aligned to EU Framework 7 thematic priorities. The inter-relation between Departments and Thematic Groups is not entirely clear and need to be properly thought out, as part of a more strategic approach.

The STIL has a common heritage with the SRI (out of which it formed in 1990) dating back to the early days of space research. It has considerable success and expertise in selected areas including space radiation physics, remote sensing instrumentation and terrestrial ionosphere/atmosphere studies. It has also had some success in more "market orientated" activities, such as eHealth, Telemedecine and Geoinformatics – and 6 products are described as being ready for implementation in industry (although it does not seem to fully acknowledge or exploit theses activities). However, it seems to lack a realistic over-arching strategic vision of its scientific and technical goals. This is undoubtedly partly due to the fact that it has no guaranteed access to space flight opportunities and must make do with a very opportunistic approach as and when suitable opportunities arise. If and when Bulgaria becomes a full member of ESA, this situation should very much improve. Furthermore, the reason for the existence of 2 separate BAS Institutes (namely, STIL and SRI) with a prime focus of space does not seem well-established except for historical reasons. Other problem areas (in common with many other Institutes) exist including a modest publishing record (with some areas of exception), an uneven age distribution, difficulty in attracting sufficient young staff, low salaries and limited public outreach.

(a) Quality and productivity

The SER is nicely written and goes to the points in a clear and concise way.

Quality

Similar to the SRI, STIL has a long and distinguished heritage of space research with involvement stretching back to the relatively early days of space research (through the personal involvement of certain senior members of staff, presumably before the foundation of STIL in 1990) in a variety of fields related to Solar-Terrestrial Research. "Guaranteed access" to the space programme of the former Soviet Union is no longer possible and so involvement is now on a more ad-hoc basis. Certainly there is evidence of involvement in missions of high quality (e.g. BIOPAN, ISS, Chandrayan, etc), but the quality of the involvement is variable - not necessarily reflecting the quality of the Institute scientists but partly reflecting the ad-hoc nature of the involvement.

Examples of academic achievements presented to the Panel are: (i) Modelling of the influence of solar and galactic cosmic rays on the system ionosphere/atmosphere and generation of post-lightning electric currents and fields; (ii) Study of the influence of chemical and dynamical processes on the stratospheric ozone and nitrogen dioxide; (iii) Investigations in the field of solar dynamics and global change; (iv) Investigations in the field of heliobiology and eHealth applications; (v) Investigations directed to study the Hazardous phenomena in the Earth space environment.

The five most important results of an applied nature include 3 different instruments and associated techniques, one space-based, one helicopter-based and one ground-based. The other two are techniques and analyses in the field of remote sensing.

Productivity

The total number of publications in journals and conference proceedings during the 5 years under consideration does seem to be following a general upward trend. However, there is an average of less than one publication per person during the period in refereed overseas science journals. This does seem to be low for an Institute that has aspirations to have an international standing. An active researcher should surely aim to have one publication per year in an international journal of standing.

The STIL is described as consisting of 77 members with an average age of around 51 years. The number of staff of age 40 or less seems to be less than 10 and only 3 below 35. This seems to be an extremely unhealthy situation.

During the period 2004-2008, 38 PhD students were trained in the Institute, but only 6 PhD were awarded.

There appears to be a number of visitors from a wide range of overseas countries but it is apparent that the visits are completely dominated by visits from one country only (Russia).

The involvement of staff members in international bodies is hard to assess. Appendix 10 lists a range of overseas institutions with which members of the Institute are involved. However, the degree and level of involvement does not appear to be sufficient for an Institute with international aspirations. There appears to be a reasonably healthy number of overseas visits by Institute staff though the effectiveness of these visits is not easily assessable.

There does seem to be some evidence of regional standing in a variety of activities (e.g. communications in rural and remote areas, preventative management of natural risks, etc) – the Panel feels that this may be an area that can be exploited further.

Overall score for Quality and Productivity: "B" for "*Work that is internationally visible. The Institute has made valuable international contributions in the field*." The STIL has a strong historical record and international visibility in some niche areas.

(b) Socio-economic Impact

There does seem to be some involvement, though not large, with national and regional bodies (either governmental or private) but to date the socio-economic impact of the activities of the Institute is not major. However, there does seem to be a significant technical capability, which is possibly not fully exploited in the context of national economic and social needs. Some emphasis should be placed on exploiting some of the

achievements of the Institute, which have the potential for such exploitation (i.e. telemedicine, remote sensing, dosimetry, etc). The establishment of a Technology Transfer Office of the type developed by the SRI might be appropriate.

The scientific work of the Institute is fairly thinly spread over a rather wide range of activities and this makes the impact of the science not always as great as it might otherwise be. This does not mean that there is not good potential but it is difficult to realise fully at present.

Overall score for Socio-economic Impact: "*Moderately relevant*."

(c) Prospects

As far as future prospects are concerned, some of the issues facing STIL are specific to itself while others are in common with other BAS Institutes. These include membership of ESA and exactly which areas of space activity to focus on. Also an issue is the very relationship between STIL and SRI. What may have been a very good motivation for 2 separate Institutes 20 years ago may not still hold true today.

The structure of the STIL does not seem necessarily to be optimum for future developments – 4 Departments and 9 Thematic Groups for an institution of 77 scientists does seem overly complicated and not ideal for facing future challenges. Furthermore, the motivation and strategy for these Departments and Thematic Groups is not well elucidated. It is questionable whether the structure is best designed for future opportunities.

There undoubtedly seems to be significant technical capability in the form of instrumentation both for ground- and space-based application. It is not clear that this capability has been fully exploited in socio/economic terms – this area is one that should have more effort devoted to it.

Just as for the BAS SRI, STIL recognises that its future potential in space research activities is partly dependant on Bulgaria's future membership of ESA. This would surely provide a better focus and over-riding strategic direction to much of the work of STIL.

Other issues that significantly affect the future prospects of STIL (and that are common to other Bulgarian institutions) include the issue of the low pay available, particularly to young scientists and also the difficulty of obtaining funding for research, particularly from non-governmental sources.

Some commonality between some activities of the STIL and those of other Institutes were also noted. Examples include geoinformatics and remote sensing, which have amongst others overlaps (and existing or potential synergy) with the Institute of Geography and the Geophysical Institute. It will be vital for the very best opportunities for exploitation (and in order not to duplicate effort unnecessarily) to maintain and strengthen close relationships with the relevant Institutes in these areas.

It is noted that the areas of activity of STIL have expanded in the recent past. But along with entering new area should go a critical analysis of whether it is appropriate to run down or even terminate certain areas, which have been followed for some time. This can be for a variety of reasons including loss/retirement of staff, changing national priorities or change of scientific priorities. In particular, the international level of activity might be used as an indicator of a particular field's current importance. It is relatively easy to continue doing something because one has always done it! The decision to withdraw

from that activity is much more difficult but sometimes it is a decision that needs to be taken.

Overall score for Prospects: "*Moderate.*"

Overall Strengths and Weaknesses

Strengths:

The Institute has considerable strengths, based on its long space heritage and its space instrumentation heritage (in niche areas). This gives it some international standing.

Weaknesses:

The weaknesses are a mixture of ones that are shared with several of the BAS Institutes and some that are specific to STIL. One of the over-riding weaknesses is an apparent lack of overall strategic planning. The strategic direction of projects undertaken, and their inter-relationships, is not always clear. So a clear understanding of which areas to be pursued and of equal importance and which are those to be dropped, is needed. Also what is the optimum "mix" of subjects? It is not possible to "do everything"!
Furthermore, the Institute does appear to have significant technical & scientific capabilities (a strength) but the commercial/ economic exploitation of these capabilities appears lacking (a weakness).
The relationship with other BAS Institutes – including the Institutes of Geography and Geophysics, and in particular the SRI – does not always appear optimum. And, in particular, is it appropriate in the current (international) context) to have two major space research-related Institutes?
Other weaknesses are mostly those that are common to several Institutes, and include issues relating to age structure, publication record and outreach. In addition, and specific to the STIL, is the possibility of significant commercial/ economic capability that has not been fully exploited.

Overall score

STIL has undoubted capabilities that could, with appropriate planning, exploit future opportunities. Commercial/ economic exploitation is as yet not fully realised and some structural weaknesses are apparent.

Recommendations

- Produce a strategic plan that, in particular, addresses which are to be the best discipline areas to be pursued by the Institute
- Produce an inventory of technical & scientific capabilities that have the capability of commercial and/ or economic exploitation, and the method for best achieving that.
- Consider the relationship with other BAS Institutes – including the Institutes of Geography and Geophysics, and in particular SRI. Is it appropriate in the current (international) context to have two major space research-related Institutes?
- Produce a plan to address the issue of the very uneven age distribution and relative unattractiveness to young scientists & engineers (perhaps by introducing schemes

to attract young Bulgarian scientists from abroad) and encouraging older scientists to take “emeritus” positions)

- Establish quantitative publishing targets for all research staff
- Establish a formal programme of public outreach.
- Critically consider the inter-relationship with the Space Research Institute vis-à-vis the full range of space activities and produce a plan for rationalisation of responsibilities and activities. Is it appropriate in the current (international) context to have two major space research-related Institutes?

Central Lab. of Seismic Mechanics & Earthquake Engineering (CLSMEE) - 511

Executive Summary

CLSMEE has a crucial role within the Bulgarian national policy of prevention against earthquake consequences, dealing both with earthquake-resistant structures and with observation of actual earthquakes' features. Owing to the obvious under-staffing of the Laboratory, as compared to its essential role, one can hardly expect a large, original contribution in the scientific disciplines underpinning the domain of activity. Nevertheless, the Panel recommends CLSMEE to concentrate a large part of the effort on exploiting the existing resources, in particular in maintaining and improving the high-standard observation network and in caring the data sets available or to be collected; in particular, a well-structured database of strong-motion records should be actively (or further) developed, as well as databases on historical earthquakes and on impact of past damaging earthquakes occurred in the country. All databases should be carefully integrated with other existing initiatives at the European level.

CLSMEE is a rather small unit with a number of staff less than 25. Its scope is fully justified by the moderate but recurrent seismic activity in the country.

In practice, topics addressed within the Laboratory range from basic observational research (Strong Motion National Network), to data on occurred damaging earthquakes and their impact, seismic solicitations and response of artefacts, building code, expertise and consultancy for many diverse civil projects (e.g. urban context, nuclear power plant, dams, waste disposals, mines, train tracks). These topics represent a very large spectrum for a small unit. These activities reflect the societal needs of the country.

(a) Quality and productivity

Quality

Topics range ideally from monitoring of earthquake activity in the country and vicinity, to survey of consequences of occurred damaging earthquakes, assessment of earthquake hazard and risk.

The relevance of the conducted projects to industry and economy is high. Participants in the projects are well identified, including those coming from other organizations than CLSMEE. Funding of the projects remains, however, somewhat obscure. The number of projects seems to be rather low, reflecting to some extent the size of CLSMEE.

CLSMEE includes only one "research fellow Degree I" among the senior research staff and only one PhD holder among the junior research staff. It is understood that the Institute calls upon external specialists, mainly from Bulgaria, when needed, especially for finite element modelling. It is obvious that the Institute is largely under-staffed vis-à-vis the tasks to be accomplished. The age distribution of staff is mainly in the 50-60 years category.

It appears that the "strong-earthquake database" is limited to some sort of (a) file(s) containing strong motion records. A true structured database, allowing navigation among the records, characterization of each individual record through certain parameterization, retrieval, metadata, etc., is foreseen but does not exist yet. In practice,

this radically restricts the use of the Institute's strong-motion data by external users, with the apparent exception of the GPhI. The Panel has understood that plans for opening up the collected data to interested users are being developed.

Regarding the academic and application achievements of CLSMEE in the last few years, in very general terms, the impression is left of "standard" achievements; it doesn't reflect a very "enthusiastic" concern even though this could be partly a matter of reporting style. In brief, CLSMEE looks rather weak in terms of scientific critical mass.

Productivity

The number of publications is scaled to the size of the CLSMEE, i.e. rather small. There are several publications published in high-ranked scientific journals. Unfortunately, they reflect more the personal interests of a few scientists than the scientific activity of the Institute.

It is surprising that CLSMEE, which is significantly application-oriented, is reported not to "have patent/licence activities during the period under consideration.

Naturally, CLSMEE is involved in different initiatives worldwide in matters of earthquake engineering and engineering seismology, which are too many and varied, but it is not evident to what extent they bring in original contributions. The adaptation of initiatives/models (like Eurocode) to the Bulgarian overall situation is already quite a task by itself, but it strongly depends on to what extent there would be a definite original contribution in the adaptation.

Overall score for Quality and Productivity: "C", for "*work that is solid and has added to our understanding and is in principle worthy of continuation. The Institute is nationally visible.*"

(b) Socio-economic Impact

Services offered by CLSMEE to Bulgaria as a whole are of paramount importance, especially in terms of protection against potential earthquake consequences. However, current activities about any kind of awareness-raising programme, in terms of occurrence of potential earthquakes, oriented toward education and general public (within Bulgaria) are falling short to satisfy the necessities. Nevertheless, a few nice booklets have been designed for the information of the general public although early warning of civil authorities upon the occurrence of a potentially damaging event falls apparently under the responsibility of the GPhI,

The hazard/risk assessment role for the whole country does not appear to be given a dedicated, sharp attention: it looks rather "standard".

An organization like the CLSMEE is obviously needed in an earthquake-prone country such as Bulgaria. There is little doubt that the Central Laboratory is well integrated in the related environment of the societal/economic demand of the country, and in the BAS in particular, as clear from evidence provided by GPhI, GI, CLG, CLMC, especially in the field of active tectonics that affects directly the assessment of seismic hazard/risk.

Overall score for Socio-economic Impact: "*Highly relevant*."

(c) Prospects

Whether CLSMEE is at its right place as a research Institute of the Bulgarian Academy of Sciences, is a matter of debate at the political level and is somewhat outside the scope of this review. It makes sense to have a research unit, within the BAS, dedicated to high-quality monitoring of seismic activity in the country, based on the highest-affordable observational techniques, as well as modelling of the response of building stock and sensitive installations to seismic solicitation (which requires immersion in a scientifically-challenging environment); on the other hand, building code activities and related expertise/consultancy could better fit in a government agency on construction. Splitting the two extreme domains could prove to be contra productive. Any ideal solution certainly depends strongly upon the national political/economical context. CLSMEE per se will gain a lot being allocated a significantly larger staff, requiring careful recruiting of the additional staff taking the overall policy adopted into consideration.

Co-operation is obviously required if an organization like CLSMEE is to render services to the country, inside Bulgaria as well as abroad; co-operation does exist with the GI on paleo-seismicity in caves. This should be carefully balanced with the genuine activity of the Central Laboratory itself, especially with such a small group embracing such a large and vital domain.

Overall score for Prospects: "*Moderate.*"

Overall Strengths and Weaknesses

Strengths:

The main strength of CLSMEE lies obviously in its essential role, within the national socio-economic environment, of contributing to the protection of the country, both population and infrastructure, against the seismic threat. Expertise of its engineering staff is an essential aspect. In addition, CLSMEE is equipped with of a high-standard strong motion observation network.

Weaknesses:

The equally obvious and critical weakness resides in the discrepancy between its national role, including its own research-oriented choices, and its overall resources (human, in particular).

Recommendations

In general, the CLSMEE would certainly benefit from a more ambitious and proactive vision of its role, e.g. in earthquake warning and advising duties vis-à-vis the authorities in co-responsibility with GPhI, in practical implementation of the building code provisions. Clearly, this will be to the benefit of the Institute and for the well-being of the Bulgarian population as a whole.

Further integration of the studies of tectonic and active fault system constraints on seismicity is strongly recommended. The advisory role of CLSMEE in siting constructions, including the track of gas-pipelines, should be strengthened.

A special case is to be made on the very important issue of developing a structured, strong-motion records database, fully integrated within the many initiatives taken at the European level.

In terms of valuable services offered to the country, a few lines could be advantageously pursued in addition to the strong-motion network and database: a database on observed impact of past earthquakes, essential for estimates of possible consequences of earthquakes to come; a well designed/populated database on historical events, to improve radically the seismic hazard assessment in the country. A good example are the Italian achievements in this domain. Of course, this needs new blood and it is obviously where the major problems lie; yet, Bulgaria is an earthquake-prone country and this should be taken into account by the BAS and the Bulgarian authorities.

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