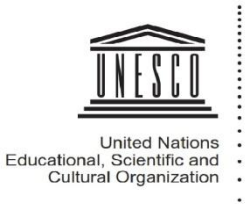

University of Craiova

Mathematics and Physics Scientific Research in South Eastern Europe And the Need for Science Policy:

Executive Summary

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Based on an e-survey conducted by
SEENET-MTP: South Eastern European Network in Mathematical and Theoretical Physics

Coordinators:
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Prof. Goran Djordjevic, University of Nis, Serbia

October-November 2012

Executive Summary

1. **Background:**

- The policy document is based on the results of the electronic survey named ***South Eastern European Mathematics &Physics E-survey***, conducted in 2009 and 2010 among 40 research institutes in the field of Mathematics and Physics from South Eastern Europe and exchange of opinions and long-term strategic approach of the scientists organised within the South Eastern European Network in Mathematical and Theoretical Physics (SEENET-MTP) during the 8-th Workshop "Quantum Field Theory and Hamiltonian Systems" (QFTHS) and the 4-th meeting "Science and Society" (S&S), held from 19 to 22 September 2012 in Craiova, Romania.
- The electronic survey was initiated through the UNESCO-BRESCE Project called **Strengthening Basic and Engineering Sciences Capacities in South Eastern Europe SEE**. *Map of Excellence in Physics and Mathematics in SEE*, signed between the Faculty of Science and Mathematics (University of Nis), as the coordinating node of SEENET-MTP, and UNESCO-BRESCE. **The project was coordinated** on behalf of UNESCO BRESCE by **Davide Poletto,** and on behalf of SEENET-MTP by **Radu Constantinescu**, at the time the dean of the Faculty of Physics, University of Craiova, Romania and **Goran Djordjevic**, professor at the Faculty of Science and Mathematics, University of Nis, Serbia and Executive director of SEENET MTP.
- The survey has collected information about the: financial profile, research staff profile, research infrastructure, performance, major research and educational programs, regional and international cooperation, from 40 research institutes, originated from: Albania, Bosnia and Herzegovina, Macedonia/FYROM, Moldova, Montenegro, Romania, Serbia.
- The research institutes are classified into three groups: Independent research groups, Academy affiliated research institutes, University affiliated units. University affiliated units are research units that are part of a university, faculty or department. Independent research groups are state-funded national institutes that have no affiliation with either any university or the National Academy of Sciences. Academy affiliated research institutes are research institutes that are affiliated or belong to their respective countries National Academy of Sciences.

2. **Strengths and Weaknesses in Mathematics and Physics Scientific Research in SEE:**

Strengths

- **In the South Eastern Europe there is a critical mass of researchers that offer the significant potential and capacity for fundamental and applied research**.
- **The scientific output from Mathematics and Physics from the SEE region is comparable with those of others research groups from the world**. When analyzing Web of Science publications by field of research, mathematics represent 2.1% of the total worldwide scientific production while physics accounts for 8.8%, giving a total of 10.9% for physics and mathematics combined – over 1,547,187 publications in the period 2005-2010. In South

East Europe (Albania, Croatia, FYR of Macedonia, Montenegro, Serbia, Bulgaria, Greece, Hungary, Romania, Slovenia and Turkey), mathematics is 3.5% of the total scientific production, while physics is 9.6% - bringing the total for physics and mathematics to 13.1%. This is 2.2% better than the worldwide average, with 87,240 publications published by the authors from the SEE compared to 668,384 publications in the whole world in the period 2005-2010. 4.5% of global scientific production in the fields of mathematics and physics comes from these 11 countries[1].

- **The scientific output from Mathematics and Physics from the SEE region represents majority of the overall scientific output in every particular country in this region, varies from app. one out of ten (in Albania, Croatia, FYR of Macedonia, Greece and Turkey) to one out of 4 scientific publications (in Montenegro, Serbia, Slovenia, Hungary, Bulgaria and Romania)**. When analyzing Web of Science publications by field of research, mathematics represent the following share of the overall scientific output in SEE countries in the period 2005-2012: 1.2% in Albania, 3.2% in Croatia, 2.4% in FYR of Macedonia, 4.2% in Montenegro, 5.4% in Serbia, 3.3% in Bulgaria, 2.5% in Greece, 4.0% in Hungary, 6.6% in Romania, 4.4% in Slovenia and 2.4% in Turkey. Physics represent the following share of the overall scientific output in SEE countries in the period 2005-2012: 9.9% in Albania, 7.7% in Croatia, 6.6% in FYR of Macedonia, 14.1% in Montenegro, 11.0% in Serbia, 21.2% in Bulgaria, 8.7% in Greece, 11.5% in Hungary, 14.9% in Romania, 11.3% in Slovenia and 6.2% in Turkey. The total for physics and mathematics represent the following share of the overall scientific output in SEE countries in the period 2005-2012: 11.2% in Albania, 10.9% in Croatia, 9.0% in FYR of Macedonia, 18.3% in Montenegro, 16.4% in Serbia, 24.5% in Bulgaria, 11.1% in Greece, 15.5% in Hungary, 21.5% in Romania, 15.6% in Slovenia and 8.6% in Turkey[2].
- **The independent research groups and the academy affiliated research institutes use an impressive research infrastructure**, followed by the university research units. More than this, in every country taken in consideration in the survey the research infrastructure is compatible with the specific needs of the research field and it's offering the support for significant scientific results.

Weaknesses

- **Although the research centres investigated are open for international cooperation, the East-West axis is the one that defines the most frequent relationships of cooperation** despite the exchanging programs inside the region.
- **The human resources aren't valued at the highest level:** the number of postdoctoral position is low and the practice of inviting personalities consecrated in research to work as associated personnel is very rare.
- **The research finance isn't the one to aspect in the advanced scientific research.**

[1] Đuro Kutlača, *Scientific Productivity in SEE in the area of Mathematics and Physics, Joint meeting on mathematical physics and science policy,* 19-22 September 2012, Craiova, Romania
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3. Prioritised possible directions of International cooperation

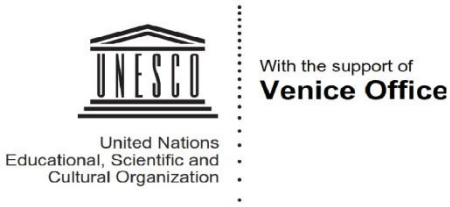
The scientists from South East Europe (Albania, Croatia, FYR of Macedonia, Montenegro, Serbia, Bulgaria, Greece, Hungary, Romania, Slovenia and Turkey) have expressed willingness and readiness for cooperation in the area of Mathematical and Theoretical Physics, given the priorities for particular research sub-fields:

- **Theoretical Physics and Mathematics,**
- **Condense Matter Physics,**
- **Nuclear and Radiation Physics,**
- **Education in the field of Physics.**

4. Directions for strategic action

In order to establish framework and conditions for successful international scientific cooperation in the South East Europe (Albania, Croatia, FYR of Macedonia, Montenegro, Serbia, Bulgaria, Greece, Hungary, Romania, Slovenia and Turkey) in the area of Mathematical and Theoretical Physics, the scientists organised within the South Eastern European Network in Mathematical and Theoretical Physics (SEENET-MTP) are proposing the following strategic actions which should be accepted, financed and managed by the national (ministries in charge of Science and Technology and Innovation, as well as for High Education) and international authorities (EU GD for Research and Innovation, UNESCO, OECD, etc.):

- **Creation of the regional cooperation networks capable to enable the communication and interrelationships between research centres,** as a solution for benefiting in common from the use of their infrastructure and human resources. Such networks will contribute to the growth of research capacities, increasing the chance of accessing international research programs (example: SEENET).
- **At a ministry level it is recommended to launch and finance special programs for interregional cooperation**, which can create new interregional networks.
- **Encouraging the change in policy of science in order to be able to hire researchers from other centres.**
- **Establishing as a priority the finance of the reintegration programs designated to young researchers** and the motivation of certain scientific personalities to contribute at the rising of powerful research schools.
- **The growth of capacity and know-how in the field of competing for research projects** and the participation to major research programs.
- **Adapting the investment policy in research from region to the European strategy of research, in the attempt to gain 3% from GDP.**
- **Turning the individual purpose of research in university affiliated units into an institutional one.**
- **Cataloguing the whole available infrastructure and sharing both that information and the infrastructure**. This way, the efficiency for infrastructure acquisitions is highly increased.



University of Craiova

Mathematics and Physics Scientific Research in South Eastern Europe And the Need for Science Policy:

Main findings of the South Eastern European Mathematics &Physics E-survey

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- The survey has collected information about the: financial profile, research staff profile, research infrastructure, performance, major research and educational programs, regional and international cooperation, from 40 research institutes, originated from: Albania, Bosnia and Herzegovina, Macedonia/FYROM, Moldova, Montenegro, Romania, Serbia.

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Strengths and Weaknesses in Mathematics and Physics Scientific Research in SEE

1. Strengths in Mathematics and Physics Scientific Research in SEE:

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- **The scientific output from Mathematics and Physics from the SEE region is comparable with those of others research groups from the world**. When analyzing Web of Science publications by field of research, mathematics represent 2.1% of the total worldwide scientific production while physics accounts for 8.8%, giving a total of 10.9% for physics and mathematics combined – over 1,547,187 publications in the period 2005-2010. In South East Europe (Albania, Croatia, FYR of Macedonia, Montenegro, Serbia, Bulgaria, Greece, Hungary, Romania, Slovenia and Turkey), mathematics is 3.5% of the total scientific production, while physics is 9.6% - bringing the total for physics and mathematics to 13.1%. This is 2.2% better than the worldwide average, with 87,240 publications published by the authors from the SEE compared to 668,384 publications in the whole world in the period 2005-2010. 4.5% of global scientific production in the fields of mathematics and physics comes from these 11 countries[1].
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- **The independent research groups and the academy affiliated research institutes use an impressive research infrastructure**, followed by the university research units. More than this, in every country taken in consideration in the survey the research infrastructure is compatible with the specific needs of the research field and it's offering the support for significant scientific results.

2. Weaknesses in Mathematics and Physics Scientific Research in SEE:

- **Although the research centres investigated are open for international cooperation, the East-West axis is the one that defines the most frequent relationships of cooperation** despite the exchanging programs inside the region.
- **The human resources aren't valued at the highest level**: the number of postdoctoral position is low and the practice of inviting personalities consecrated in research to work as associated personnel is very rare.
- **The research finance isn't the one to aspect in the advanced scientific research.**

3. Finance

- The majority of the units questioned have an annual budget between 100.001 and 500.000 Euro, 15% have a budget smaller than 10.000 Euro, while 7.5% have an annual budget of more than 5 million Euro. Furthermore, independent research groups have an annual budget of around 8 million euro, exceeding by much the budget of the other two. Academy affiliated research institutes have an average annual budget of almost one million euro, while university affiliated research units have just a bit over 700.000 euro.
- When talking about the average percent used for research activities, independent research groups use 99.5 percent of their entire annual budget, about the same as academy affiliated institutes. This is not the case with the university affiliated research units, because, here, it is a totally different story with the budgetary strategy. Only 20 percent of the entire budget is dedicated to support research activities. On top of this, 10% of the institutes do not allocate any funds to research activities. In absolute values, independent research groups' benefit, on average, of over 7.5 million euro annually for research activities, the academy affiliated research institutes use around 950.000 euro and university affiliated units' ranks struggle for survival in the research domain, with a research budget of only 140.000 euro per year.
- Considering the fact that the university affiliated units represent 82 percent of the total number of research institutes taken in consideration, one can consider this a very important issue. Underfunding is a general problem in higher education in South Eastern Europe that obviously directly affects teaching but especially research activities because it cannot be done without financing or poor infrastructure.
- Considering the way the budget is handled one can understand what the management and the policy are using as priorities. The fact that the university affiliated units use only 20

percent for research activities only shows that scientific research isn't a real top priority. Professors working with university affiliated units, must write books, scientific articles, in other words, have to do scientific research in order to qualify for promotion, but this purpose is expressed at an individual level, not at an institutional one.

4. Scientific output

- The Universities from the SEE aren't the top initiators of the scientific research mainly because they don't have personnel full time employed for research activities.
- A very important part of reflecting the performance of a research unit that specializes in Physics and Mathematics is the number of publications in peer-reviewed journals, where independent research groups have a mean of 524.5 publications in 2000-2004 and 667.25 in 2005-2009, being by far the most performing. With almost half less in 2005-2009, the second most performing are academy affiliated research institutes. The least performing are the university affiliated units, with only 84.71 mean publications in 2000-2004 and 161.59 in 2005 -2009.
- Another important performance indicator is the number of peer reviewed proceedings, where university affiliated units are the least performing, with a average of 29.83 proceedings in 2000-2004 and 49.11 in 2005-2009. In this comparison, independent research groups and academy affiliated research institutes are almost at a tie: the first is the most per formant in 2000-2004 with 94.67 proceedings, but comes in second with 77.75 published proceedings for 2005-2009.
- Academy affiliated research institutes are the most prolific, with a mean of 2400 citations in 2000-2004 and 3750 citations in 2005-2009. They are followed by independent research groups, with an average of 1168.33 citations in 2000-2004 and 2191.33 in 2005-2009. University affiliated units are underperforming again, tailing with 315 mean citations in 2000-2004 and 522 in 2005-2009.
- By comparing the budget of the units with the number of peer-reviewed publications, one can clearly observe that there is clear connection between the money spent on research and the performance of the unit - the "top spender" manages to have the most publications for both 2000-2004 and 2005-2009. The budget of the unit also has a strong influence on the number of citations, following the same trend.
- Between 2000 and 2004, almost half of the respondents (42.5%) indicated that they obtained have no patents. 5% indicated that they have obtained between 1 and 50 patents. Same percentage is for those who indicated a number of patents between 101 and 500. The trend is consistent for 2005 - 2009.
- University affiliated units specialized in physics and mathematics are at the last position in every item we've used to measure scientific output, even though they are the most numerous group.

5. Human Resources and Infrastructure

- Regarding the number of staff involved in research activities, most of the institutes (40%) benefit from up to 25 persons involved in research, 11 institutes have between 26-50 researchers and 2 institutes (5%) benefit from more than 250 persons involved in research activities (The Gheorghe Asachi Technical University in Iasi and Horia Hulubei Institute of Physics and Nuclear Engineering in Magurele).
- 60% of the institutes (24) have no international researchers and only one institute has more than 5 (a number of 25 international researcher at The Gheorghe Asachi Technical University in Iasi). 9 institutes did not provide with the information along the questionnaire. 32.5% of the institutes (13) have no senior scientists, the same percentage have up to 5 full professors and 2 institutes (5%) benefit from more than 25 senior researchers. A quarter of the institutes did not respond to this matter.
- Because of not enough infrastructures, either on-site or with the help of other national / international institutes, research is affected in most units analyzed.
- When ask which are the most needed resources and services not currently available at their centre, 65% of respondents indicated they have at least one missing research resource.
- On the other hand, regarding capabilities, over half of the respondents (55.0%) indicated that they have one major facility in their research centre and 15.0% that they have between 2-5 major facilities. It is important to see that an important percent (22.5%) indicated that they do not have any major facility in their centre. Most of the equipments were bought during 2006-2008, as 37.5% of the respondents indicated. 12.5% of centres indicated that they have new equipments that were bought starting with 2009. It is also important to see that another important part of the centres have facilities, that are bought before 1996 (20.0% of respondents indicated this).
- It is reasonable to conclude that many research units live in scientific isolation. Most of the centres (16) have access to only 1 to 10 international journal, while only nine centres have access to more than 100 international peer-reviewed journals. 17 centres mentioned that they have access to a limited number of electronic databases (between 1 and 3 databases), and less than half (9) indicated that they have access to a quite large number of data bases (between four and six).

6. International cooperation

- The link between the research units and economical environment is weak. One can noticed that there is no financial collaboration between the research units and the private sector, regardless the affiliation. For all 3 categories of research units, the main finance source is public funds, from their own country – representing over 90% of total funds.
- The level of communication and cooperation between the research groups from the region is also low in number.
- In a period in which international cooperation is mostly recommended and supported, especially in research, most of our respondents do not benefit of such activities. The statistical analysis performed on the answers provided by the 40 respondents, shows that

55% of them have not developed research programs in collaboration with other units. Also, a low level of cooperation is identified when we are discussing about scientific research programs (Masters, PhD). 72.5% of research units' participants at the e-survey said that they did not implement any of these programs. 33% respondents said that they have not organized joint meetings, conferences or workshops. 63% from the 40 units surveyed mentioning that they have not developed any research grants in cooperation with institutes from other countries.

- Analyses regarding all the activities undertaken by all the respondents are indicating a trend that can be found in other parts of our report: independent research groups are those who have developed the most consistent collaboration activities**,** while academy affiliated institutes and university affiliated maintain a great distance.
- There are cooperation activities where all the three types of units have obtained averages of zero or averages very close to zero. (*Fellowships, Exchange programs, other initiatives*).

Strategic actions in promoting Mathematics and Physics Scientific research in SEE

7. Prioritised possible directions of International cooperation

The scientists from South East Europe (Albania, Croatia, FYR of Macedonia, Montenegro, Serbia, Bulgaria, Greece, Hungary, Romania, Slovenia and Turkey) have expressed willingness and readiness for cooperation in the area of Mathematical and Theoretical Physics, given the priorities for particular research sub-fields:

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Complete report is available on the internet address of the SEENET-MTP - South Eastern European Network in Mathematical and Theoretical Physics: http:\\seenet-mtp.info