PARTICIPAREA ROMÂNIEI LA PROGRAMELE CADRU DE CERCETARE ALE U.E. ÎN DOMENIUL MICRO ȘI NANOMATERIALELOR. STRATEGIE PE TERMEN MEDIU-LUNG ȘI ALOCAREA FINANȚĂRII PUBLICE NAȚIONALE DIN DOMENIUL ȘTIINȚĂ ȘI INOVARE

ROMANIAN PARTICIPATION TO THE EU FRAMEWORK PROGRAMME FOR RESEARCH IN THE MICRO AND NANOMATERIALS FIELD. MEDIUM--LONG STRATEGY AND PUBLIC FUNDING ALLOCATION FOR SCIENCE AND INNOVATION

VIOREL VULTURESCU[1]*, ELENA DINU[2], VIRGINIA VULTURESCU[3]

[1]Universitatea Politehnica București – Facultatea IMST, Departament Teoria Mecanismelor și Roboților
[2]Universitatea Politehnica București – Facultatea Mecanică și Mecatronică, Departament Echipamente pentru Procese Industriale
[3]Institutul Național de Cercetare-Dezvoltare Chimico-Farmaceutică – ICCF București

Romania participates to the EU Programme since 1998, when the 5th Framework Programme included two new members (Romania and Bulgaria). Starting with 2007, Romania is equal in rights and obligations with other EU member states like Germany, Italy, France, etc.. Strong competition with European homologues, high quality standards imposed in these projects, lack of international visibility as well as links with scientific communities from EU member states, led to a poor performance of Romanian participants.

This paper presents the evolution of Romanian participation to the EU Framework programme and an analysis of "macromaterials and nanomaterials" area where Romanian scientific community performed at EU average or above. This area is one of those where it has been also well performed to other European instruments (ex. MANUNET), it could be considered as a working base for a future national strategy for research (after 2020), where performance in some areas and fund raising from European and international sources should determine public allocation for research, technological development and innovation. There are also presented those measures to be taken, in order to fulfill its commitments from EU 2020 Strategy.

România participă la programele de cercetare ale Uniunii Europene încă din anul 1998, atunci când Programul Cadru 5 (PC5) a primit încă doi noi membrii (România și Bulgaria). Începând cu anul 2007, România este egală în drepturi și obligații cu celelalte state membre UE, precum Germania, Italia, Franța și altele. Concurența acerbă cu omologii europeni, standardele înalte de calitate impuse în aceste proiecte, lipsa vizibilității internaționale precum și a legăturilor cu comunitățile științifice din statele membre UE a condus la o prestație nesatisfăcătoare a participanților din România.

Lucrarea prezintă evoluția participării României la Programele Cadru ale UE precum și o analiză a domeniului "micromaterialor și nanomaterialelor" unde comunitatea științifică din România a performat la media UE sau peste aceasta. Acest domeniu este și cel la care s-a participat foarte bine și la alte tipuri de instrumente europene (ex. MANUNET), putându-se considera ca un "studiu de caz" și pentru altele. Analiza poate fi considerată și o bază de lucru pentru o viitoare strategie națională de cercetare (post 2020), unde performanța în anumite domenii și atragerea de fonduri europene și internaționale ar trebui să determine alocarea finanțării naționale pentru cercetare, dezvoltare tehnologică și inovare. Sunt de asemenea prezentate și acele măsuri necesar a fi luate pentru ca România să își îndeplinească angajamentele luate în cadrul Strategiei UE 2020.

Keywords: *EU, Research Framework Programmes, Romanian participation, micro and nano-materials field*

1. Introduction

Analysis of participation to EU FP is a very important element for every EU member state (EU MS) and associated state (AS) which allows (list is not exhaustive): a) identification of scientific areas where that specific country is competitive at EU level; b) financial analysis of participation, respectively amounts that are "recovered" from the EU budget, c) proposal of research topics via Programme Committees that could contribute not only to solving European R&D issues but to gain knowledge which strengthen companies competitiveness from that EU MS. Several studies [1 - 5] performed by EU MS analysed performance to EU FP and drawn useful conclusions that support policy makers in R&D and economy at national level.

Starting with 2007 (beginning of FP7), Romania is equal in rights and obligations with other EU member states like Germany, Italy, France, etc. Strong competition with European homologues, high quality standards imposed in these projects, lack of international visibility as well

* Autor corespondent/*Corresponding author*, Viorel Vulturescu
E-mail: vvultur@yahoo.com

as links with scientific communities from EU member states, led to a poor performance of Romanian participants.

It is worth mentioning that FP projects are managed by Directorate General Research&Innovation of the European Commission (DG R&I) and not by a management authority or intermediate body as it is the case of Structural and Cohesion Funds. One of the arguments for this approach resides from the fact that EU FP projects are proposed and implemented by pan-European consortia (universities, R&D institutes, NGOs, companies, public authorities, etc.).

2. Methodology

This paper presents Romanian participation to FP 6 (2002-2006), FP 7 (2007 – 2013) and Horizon 2020 (2014-2020), the last two FPs as EU MS in the area of ”macromaterials and nanomaterials”. It is also included FP6 as participation to this Programme which paved the way towards participation as “new MS” without any financial reduction from the EU or possibility to cover the financial contribution from PHARE Programme.

3. FP 6 in Brief [6]

FP6 is the European Community Framework Programme for Research, Technological Development and Demonstration. It is a collection of the actions at EU level to fund and promote research. Based on the Treaty establishing the European Union, the Framework Programme has to serve two main strategic objectives: Strengthening the scientific and technological bases of industry and encourage its international competitiveness while promoting research activities in support of other EU policies. These two objectives are setting the general scene for choosing priorities and instruments. With a budget of 17.5 billion EUR for the years 2002 - 2006 it represents about 4 - 5 percent of the overall expenditure on RTD in EU Member States. The main objective of FP6 is to contribute to the creation of the European Research Area (ERA) by improving integration and co-ordination of research in Europe which is so far largely fragmented. At the same time research will be targeted at strengthening the competitiveness of the European economy, solving major societal questions and supporting the formulation and implementation of other EU policies.

FP6 is made up of three main blocks of activities grouped in two specific programmes plus a third specific programme on nuclear research:

- BLOCK 1: FOCUSING AND INTEGRATING EUROPEAN RESEARCH
- BLOCK 2: STRUCTURING THE ERA
- BLOCK 3: STRENGTHENING THE FOUNDATIONS OF ERA

The first block (Block 1) of activities “focusing and integrating” European research defines seven thematic priority areas of research. They cover those areas where the EU in the medium term intends to become the most competitive and dynamic, knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion. As one of the measures to implement the international dimension of FP6, this block is open to participation by organisations from third countries with substantial funding included in the budget.

The seven thematic priorities of Focusing and integrating European research are: 1. Life sciences, Genomics and Biotechnology for Health 2. Information Society Technologies (IST) 3. Nanotechnologies and nanosciences, knowledge-based multifunctional materials, new production processes and devices (NMP) 4. Aeronautics and Space 5. Food Quality and Safety 6. Sustainable Development, Global Change and Ecosystems 7. Citizens and Governance in a knowledge-based society.

The FP 6 budget was 17.883 million EUR (plus 1.230 million EUR for EURATOM). With a budget of EUR 1 429 million for 2002-2006, the NMP priority under FP6 is conceived to promote the transition towards knowledge-based products and services through breakthroughs in new applicable knowledge and long-term RTD. The NMP priority supports research projects in the area of "Nanotechnology and nanosciences, knowledge-based multifunctional materials and new production processes and devices". (source: http://collections.europarchive.org/haeu/20161115164255/http://cordis.europa.eu/nmp/welcome.htm). In the Table 1 and Table 2 below is presented the Romanian contribution to FP6, as well as the corresponding number of contracts, and recovery rate. For Priority 3 (NMP), the Romanian financial contribution to FP6 budget is 65,290 million EUR (see Table 3).

Overall, the recovery rate was good to the following FP 6 priorities: ”Global change and ecosystems”, “Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices”, “Science and society”.

NMP was second on this ranking which proves that Romanian scientific community paid lots of efforts to participate to this programme. However, this recovery rate was considered as good in the context that Romania did not pay the full amount of money as if it would have been as if Romania would be an EU member state. Also it has to be taken into account that 96,6% is an excellent recovery rate. Such an effort should have been reflected in a similar participation to the national programme in force at that time.

4. FP 7 in brief [8]

While FP 6 duration was of four years, FP7 lasted seven years from 2007 until 2013. The

Table 1

Financial Contribution to the FP6 Budget (by year, from national budget, and PHARE Programme) [7]
Contribuția financiară la bugetul PC6 (pe an, din bugetul național și din programul PHARE)

Period (years)	Total (EUR)	RO Contribution (EUR)	PHARE Contribution (EUR)
2003 - 2006	77.266.000	38.633.000	38.633.000
2003	14.240.000	7.120.000	7.120.000
2004	17.230.000	8.615.000	8.615.000
2005	20.237.068	10.767.068	9.470.000
2006	13.582.450	6.791.225	6.791.225
Total	**65.289.518**	**33.293.293**	**31.996.225**

Table 2

Participation to FP 6 contracts, by project type, to NMP priority [7]
Participarea în proiecte PC6 - prioritatea NMP, pe tipuri de proiecte

Total nr. of contracts	Total nr. of contracts with RO participation	Nr. of RO participants	Nr, of submitted proposals	Project type									
				IP		NoE		STREP		CA		SSA	
				total	RO	total	RO	total	RO	total	RO	total	RO
241	27	548	372	47	10	18	4	144	6	9	5	23	2

Table 3

Financial contribution to each specific programme, number of contracts and recovery rate in FP 6, for Romanian participants [7]
Contribuția financiară pentru fiecare program specific, numărul de contracte și rata de recuperare la PC6, pentru participanții români

Specific Programme / Priority	PC6 budget (kEUR)	RO contribution to FP6 (kEUR)	Contracts with RO participation (kEUR)	Recovery rate (%)
Nanotechnologies and nanosciences, knowledge - based multifunctional materials and new production processes and devices (NMP)	1.429.000	4.881	4.714	96,6

programme had a total budget of over 50 billion EUR. This represented a substantial increase compared with the previous FP6 (41% at 2004 prices), a reflection of the high priority of research in European Union. FP7 was seen at the time of its launch as key tool to respond to Europe's needs in terms of jobs and competitiveness, and to maintain leadership in the global knowledge economy. FP7 is open to participation from any country in the world. the EU Member States enjoy the broadest rights and access to funding. The same conditions apply to Member States and to countries associated to FP7 (countries paying a share to the overall budget of FP7). In FP 6 these countries included EEA countries (Iceland, Norway, Lichtenstein), candidate countries (e.g. Turkey, Crotia), as well as Israel and Switzerland. The Specific Programmes constitute the five major building blocks of FP7. The core of FP7, representing two thirds of the overall budget, is the **Cooperation programme.** It fosters collaborative research across Europe and other partner countries through projects by transnational consortia of industry and academia. Research will be carried out in ten key thematic areas: 1) Health, 2) Food, agriculture and fisheries, and biotechnology, 3) Information and communication technologies, *4) Nanosciences, nanotechnologies, materials and new production technologies,* (NMP) 5) Energy, 6) Environment (including climate change), 7) Transport (including aeronautics), 8) Socio-economic sciences and the humanities, 9) Space, 10) Security.

The **Ideas programme** will support “frontier research” solely on the basis of scientific excellence. Research may be carried out in any area of science or technology, including engineering, socio-economic sciences and the humanities. In contrast with the Cooperation programme, there is no obligation for cross-border partnerships. Projects are implemented by “individual teams” around a “principal investigator”. The **People programme** provides support for researcher mobility and career development, both for researchers inside the European Union and internationally. It is implemented via a set of Marie Curie actions, providing fellowships and other measures to help researchers build their skills and competences throughout their careers. The **Capacities programme** strengthens the research capacities that Europe needs if it is to become a thriving knowledge-based economy. It covers the

Table 4

Romanian participation to NMP priority of FP 7 [9] */ Participarea României la apelurile NMP din PC7*

Submitted Proposals		Retained Proposals		Success Rates	
Applicants in eligible proposals	EC financial contribution in eligible proposals to applicants (euro)	Number of Applicants in retained proposals	EC financial contribution in retained proposals to applicants (euro)	Applicants (%)	EC financial contribution to applicants (%)
288	65.708.999	93	16.333.203	32,29	24,86

Table 5

Financial participation to FP7 (all projects and participants) [9] **/** Participarea financiară la PC7 (toate proiectele și participanții)

Total Number of FP7 Projects	Total Number of FP7 participants	EC Financial Contribution to Projects (KEUR)	Total Cost for Projects (KEUR)	EC Financial Contribution to all participants (KEUR)	Total Cost for all Participants (KEUR)
23.808	128.312	42.968.690	60.094.978	42.973.065	60.266.5834

Table 6

Projects and participants from Romania to NMP priority of FP7 [9] / *Proiecte și participanți români la apelurile NMP din PC7*

Number of Projects	RO participants in NMP Projects	EC Financial Contribution to NMP Projects (EUR)	Total Cost for NMP Projects (EUR)	EC Financial Contribution to RO participants (EUR)	Total Cost for Participants (EUR)
72	1.118	329.934.167	469.211.316	14.724.766	20.886.726

following activities: a) Research infrastructures, b) Research for the benefit of SMEs, c) Regions of Knowledge, d) Research Potential, e) Science in Society, f) Specific activities of international cooperation. The **programme for nuclear research and training activities** comprise research, technological development, international cooperation, dissemination of technical information, and exploitation activities, as well as training.

As presented in Tables 4, 5 and 6, the recovery rate far from the one in FP6, but this is due to the fact that in FP7, Romania have not have any financial reduction granted by the EC. Additionally, the FP7 budget was significantly higher than the one for FP6, as well as its duration was almost doubled.

5. H2020 in Brief [10]

Horizon 2020 is the biggest EU research and innovation programme ever. It will lead to more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market. Almost €80 billion1 of funding is available over 7 years (2014 to 2020) – in addition to the private and national public investment that this money will attract. Excellent science, competitive industry and tackling societal challenges are at the heart of Horizon 2020. Targeted funding will help to ensure that the best ideas are brought to the market faster – and are used in our cities, hospitals, factories, shops and homes as quickly as possible. Excellent science, competitive industry and tackling societal challenges are at the heart of Horizon 2020. Targeted funding will help to ensure that the best ideas are brought to the market faster – and are used in our cities, hospitals, factories, shops and homes as quickly as possible.

Excellent Science: Horizon 2020 was designed to boost the EU's position as a world leader in science, attracting the best brains and helping our scientists collaborate and share ideas across Europe. It will help talented people and innovative firms boost Europe's competitiveness, creating jobs along the way, and contributing to a higher standard of living – benefiting everyone. The funding for each priority are:

- Frontier research funded by the European Research Council (ERC): 13.095 billion EUR,
- Marie Skłodowska-Curie Actions - Funding: 6.162 billion EUR,
- Future and emerging technologies - Funding: 2.696 billion EUR,
- World-class infrastructure - Funding: 2.488 billion EUR.

Industrial leadership: To be the best at what it does, Europe needs to invest in promising and strategic technologies, such as those used in

advanced manufacturing and micro-electronics. But public funding alone is not enough: the EU needs to encourage businesses to invest more in research, and target areas where they can work with the public sector to boost innovation. Businesses gain by becoming more innovative, efficient and competitive. This in turn creates new jobs and market opportunities. Every 1 EUR invested by the EU generates around 13 EUR in added value for business. And increasing investment further to 3% of GDP by 2020 would create a further 3.7 million jobs.

- Leadership in enabling and industrial technologies - Funding: 13.557 billion EUR,
- Access to risk finance - Funding: 2.842 billion EUR,

Small and medium enterprises (SMEs) – a key source of jobs and innovation – receive special attention in Horizon 2020. They receive funding at least 3 billion EUR, which are allocated to the SME instrument.

Societal challenges:

- SC1- Health, demographic change and wellbeing - Funding: 7.472 billion EUR,
- SC2- Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy - Funding: 3.851 billion EUR,
- SC3- Secure, clean and efficient energy - Funding: 5.931 billion EUR,
- SC4- Smart, green and integrated transport - Funding: 6.339 billion EUR,
- SC5- Climate action, environment, resource efficiency and raw materials - Funding: €3.081 billion EUR,
- SC6- Europe in a changing world - inclusive, innovative and reflective societies - Funding: 1.309 billion EUR,
- SC7- Secure societies - protecting freedom and security of Europe and its citizens - Funding: 1.695 billion EUR.

Spreading excellence and widening participation (Funding: 816 million EUR)

- 'Teaming' excellent research institutions with lower performing counterparts to create or upgrade centres of excellence,
- 'Twinning' institutions, including staff exchanges, expert visits and training courses,
- Establishing 'ERA Chairs' to attract outstanding academics to high potential institutions,
- A Policy Support Facility to help improve national and regional research and innovation policies,
- Providing excellent researchers and innovators with better access to international networks,
- Strengthening the transnational networks of National Contact Points to provide information to those seeking support.

Science with and for society (Funding: 462 million EUR)

Innovation actions in Horizon 2020

Social Sciences and Humanities

Nuclear research for all citizens (Funding: 1.603 billion EUR)

Science for policy – the role of the Joint Research Centre (JRC)

Romanian participation to "NMBP" H2020[1]

In H2020, there is no "NMP" area, in the same manner as in FP7 and FP6. However, there are three domains ("Manufacturing", "Advanced materials" and "Nanomaterials") that toghether could be considered as similar as NMP in previous two framework programs. In the tables below, Romanian participation to these three areas are presented (see Tables 7 – 10).

Table 7

Participation of Romania to "manufacturing", "advanced materials" and "Nanomaterials" of H2020 [9]
Participarea României la apelurile "Producţie avansată", "Materialele avansate" şi "Nanomateriale" din H2020

Priority Area		Signed grant agreements with at least one participant	Participations in the selection	All participations in grant agreements	Project cost in grant agreements	Project cost for all participations in selection	EU financial contribution to grant agreements	EU financial contribution to all participations in the selection
					(KEUR)	(KEUR)	(KEUR)	(KEUR)
Industrial leadership	**Nanomaterials**	4	5	95	37,767.4	1,367.6	23,575.7	886,9
	Advanced Materials	3	3	74	60,509,420	2,760,608	21,243.9	962.5
	Advanced Manufacturing	7	10	101	59,951,398	3,757,788	37,726.8	2,405.5

[1] Data available in eCORDA, dowloaded in January 2018

Table 8

Participation of Romania (Success rate) to "advanced materials" part of NMBP area of H2020 [9]
Participarea României (rata de succes) la apelurile "materiale avansate", parte a NMBP din H2020

Country	Unique Participants from a Country	Participations from a Country		SME Participations		EU Financial Contribution for Participants from a Country	
	No.	No.	%	No.	%	EUR	%
RO	2	3	0.25	1	0%	962,449	0.19
Total EU Member States	**742**	**1,075**	**90.64**	**279**	**94.26**	**463,279,273**	**93.05**

Table 9

Participation of Romania (success rate) to "Nano" part of NMBP area of H2020 [9]
Participarea României (rata de succes) la apelurile "nano" parte a NMBP din H2020

Country	Unique Participants from a Country	Participations from a Country		SME Participations		EU Financial Contribution for Participants from a Country	
	No.	No.	%	No.	%	EUR	%
RO	4	5	0.39	0	0	886,891	0.17
Total EU Member States	**892**	**1,168**	**90.89**	**553**	**92.63**	**496,433,574**	**94.30**

Table 10

Participation of Romania (success rate) to "manufacturing" part of NMBP area of H2020 [9]
Participarea României (rata de succes) la apelurile "producție avansată", parte a NMBP din H2020

Country	Unique Participants from a Country	Participations from a Country		SME Participations		EU Financial Contribution for Participants from a Country	
	No.	No.	%	No.	%	EUR	%
RO	9	10	0,45	3	0,1	2,405,308	0.27
Total EU Member States	**1374**	**2,076**	**94.24**	**673**	**96.1**	**843,651,507**	**95.29 %**

6. Results, discussions and conclusions

"NMP (micro- and nano-materials)" is an area that is of huge interest for European and international research. Scientists from several communities participates to projects from these areas. Romania is performing well below its potential and subsequently its participation is lower than other member states, due to several causes (list not exhaustive):

- **Continuous decrease of national funding**
- **Lack of participation in European consortia which submit project proposals.** This may be caused by lack of visibility, as Romanian researchers do not participate to important scientific events (e.g. conferences).
- **Lack of state of the art R&D facilities** (e.g. equipment) which should allow Romanian scientists to perform tests, analysis or experiments in full compliance with international regulations.

difficult to perform to the desired level of

for R&D sector in the last ten years led to decrease of competitiveness of "micro- and nano-materials community" no matter if they are in universities, national research institutes, companies, NGOs, etc.

- **Other pan-European instruments like ERA-NET projects** contributed significantly to consolidating European integration of Romanian scientific community. In this respect, it has to be stressed that MANUNET[2] was one of the most successful project that gathered participants all over Europe, including from this research community of Romania.
- Even in these difficult conditions (see above), **"micro- and nano-materials community" continued to participate to EU framework programme and to attract EU funds in Romania.** However, they still have to make the step forward and to submit project proposals as coordinators.

The corresponding area in the National Plan for Research is "eco-nano technologies and advanced materials". Still, national calls are not similar with the ones in the EU Frameworks Programs as there are no dedicated topics, budgets or particular targets set by the Government. Additionally, the national budget is approved on yearly basis, which lead to uncertainties and lack of financial security (project budget). A possible solution to (indirectly) increase the recovery rate from EU Framework Programmes is to channel financial resources towards those scientific areas that successfully performed at European level, which is the case on "micro- and nano-materials community".

At this stage (January 2018), H2020 Work Programs are already approved by the Programme management. Based on previous years (last years of participation to FP 7 and FP 6), it is not expected a boost of Romanian participation. By contrary, it will be probably one of the lowest participation during the whole H2020, as scientific topics and their corresponding budgets are the lasts to be covered during this program. Subsequently, it is not expected an important modification in the statistics presented above (percentages).

It is also worth to be mentioned that Romanian allocation for R&D have not passed more than 1% (except 2008 when it was an additional 0,1%) of GDP (since 2005, before the EU accession). Under these circumstances, it is competitiveness, Romania being the 9th country in the EU, by area [12], should have a similar position on the ranking of funds recovery, which is not the case. If it budget appropriations [11] is taken into account, Romania holds the 26th position out of 28 Member states, which is not at all encouraging for a potential increase of EU funds from Framework Programmes.

REFERENCES

1. German Participation in the Sixth European Framework programme for Research, Technological Development, Federal Ministry of Education and Research, Bonn, Berlin 2009, downloaded 10 January 2018.
2. Una panoramica sulla partecipazione italiana a Horizon 2020, APRE 2017 – July 2017, downloaded 10 January 2018.
3. Kallenbach, S., Toussain, R., Verhaege, D., Gabla E., Margaria, C., Magnien, M. Evaluation de politique publique Annexes Tome 1 La participation français au programme-cadre européen de recherche et de l'innovation, February 2016, downloaded 10 January 2018.
4. David, A. The participation of Austria and Hungary in the Framework Programmes for Research and Technological development of the European Union. A comparative analysis. Romanian Journal of European Affairs, vol. 16, nr. 4, Dec. 2016, p 48-67.
5. Österreichische Forschungsförderungsgesellschaft (FFG) 2015: Österreich in Horizon 2020, Cockpitbericht zum Datenstand 30. Oktober 2015, source: https://era.gv.at/object/document/2233/attach/FFG_Cockpitbericht_H2020_November_2015.pdf, downloaded 10 January 2018.
6. FP 6 in brief, https://ec.europa.eu/research/fp6/pdf/fp6-in-brief_en.pdf, downloaded in January 2018.
7. Romanian participation to FP 6. Internal report of National Authority for Scientific Research.
8. FP 7 in brief, https://ec.europa.eu/research/fp7/pdf/fp7-inbrief_en.pdf, downloaded in January 2018.
9. CORDA, the COmmon Research DAta warehouse, is collecting proposal, evaluation and grant management data of all the operational systems automating key business processes around the Framework Programmes, H 2020 – FP 5. eCORDA is a subset (reduced scope to H2020, FP7, FP6) including databases , refreshed three times a year.
10. H2020 in brief, The EU Framework Programme for Research & Innovation, European Union, 2014, ISBN: 978-92-79-33057-5 doi:10.2777/3719.
11. Share of government budget appropriations or outlays on research and development, source EUROSTAT, (% of total general government expenditure), see http://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=tsc00007 (downloaded January 2018).
12. Area by NUTS 3 region, source EUROSTAT, downloaded January 2018.

****

[2] https://www.manunet.net/