Evaluation of the Swiss National Science Foundation: Funding of infrastructure and development of research fields

Self-evaluation report of the SNSF

Commissioned by the State Secretariate for Education, Research and Innovation (SERI) as the basis for an evaluation carried out by the Swiss Science and Technology Council (SSTC)

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FNSNF
Swiss National Science Foundation

Table of Contents

1. Summary

This self-evaluation report from the Swiss National Science Foundation (SNSF) was commissioned by the State Secretariat for Education, Research and Innovation (SERI) as the basis for a periodic review to be carried out by the Swiss Science and Technology Council (SSTC). It focuses on the SNSF's role in the funding of research infrastructures and research fields.

The responsive-mode funding schemes at the core of the SNSF's portfolio, open to all research disciplines and topics, accounted for 83% of total funding between 2008 and 2012, including career funding. These schemes and existing opportunities for the specific support of research fields and infrastructure are considered from a variety of perspectives. This evidence is then drawn on to derive suggestions for the future funding of research infrastructures and research fields.

Funding of research fields to date

Out of over CHF 2 billion granted between 2008 and 2012 for project funding and Sinergia, the main funding schemes in the **responsive mode**, one fifth went to the humanities and social sciences, the remainder was spread roughly equally between mathematics, natural and engineering sciences as well as biology and medicine. Amounts awarded by research area followed amounts requested in a linear fashion, which suggests that the SNSF was on the whole well able to adapt to changing demand.

As only limited data is available, it is difficult to estimate the **coverage of the Swiss scientific community** by the SNSF, especially for the universities of applied sciences and teacher education. Roughly 30% of researchers employed at the Universities and ETHs were SNSF 'customers' in 2011. The coverage was highest in the MINT disciplines (mathematics, informatics, natural sciences and technical sciences), followed by biology and medicine, and heterogeneous in the humanities and social sciences.

For research in biology and medicine, Swiss Pubmed publications (as an indicator of research activity) were modelled semantically and compared to SNSF applications. The **'topic modeling'** shows that for a given research activity, interest in SNSF funding can differ considerably. Even if the method does not currently allow for conclusions to be drawn regarding the SNSF coverage of the research community, its potential is high, since it can dynamically include interdisciplinary research and new research fields.

In several cases, **specific initiatives for research fields or domains** complemented responsive-mode funding:

- Between 1999 and 2011, the **DORE** funding programme aimed to build up expertise for practice-oriented research in the areas of health, social work and art at the universities of applied sciences and teacher education (UASs and UTEs). With funding exceeding CHF 50 million between 2004 and 2011, DORE encouraged research as numerous centres of competence were set up. However, the number of applications from the UASs and UTEs in the category of 'use-inspired basic research', introduced within project funding to follow-up on DORE, has not yet increased significantly since 2011.
- Several **initiatives** since 2004 have aimed to strengthen clinical research and improve the quality of patient data. They include the promotion of cohort studies, support for Clinical Trial Units at hospitals and the Special Programme for University Medicine. These initiatives were included in the SNSF's multi-year planning and periodically reviewed. Grants between 2008 and 2012 amounted to CHF 107 million.

- In the natural sciences and humanities, **long-term projects,** which may extend over several decades, are funded within the scope of project funding. This is the case for projects in experimental physics, chemistry, astronomy, astrophysics or climate research, which depend on complex instruments or large international infrastructures and where the high competition for access to infrastructure ensures quality. In the humanities, the SNSF funds publishing projects, collections of legal sources or dictionaries of high international standing.
- Since 2006, projects indicated as **interdisciplinary** by applicants have been evaluated by a specific committee. Apart from researchers who also submit applications to the disciplinary divisions, this scheme attracts 'new customers' who are often affiliated to UASs or other institutions outside the Cantonal Universities and the ETH Domain.
- The thematic programmes **SystemsX.ch** and **Nano-Tera** were initiated by researchers. Each had a separate budget line of approx. CHF 100 million for 2008-2011. The SNSF was mandated by the federal authorities to conduct scientific quality assurance. Of SystemsX.ch customers, 95% have also, rather successfully, submitted applications in project funding. For Nano-Tera, about 20% of applicants have never applied for projects. Since Nano-Tera is in large parts use-inspired, it may well be that it attracts researchers not interested in the conventional schemes.

Infrastructure funding to date

Between 2008 and 2012, the SNSF invested over CHF 225 million in research infrastructures, including **R'Equip** grants for the purchase of new instruments for research, **long-term researcher-driven proposals** financed via the budget of divisions I, II and III, separate budgetary envelopes and calls in the **field of biology and medicine** as well as additional mandates from the SERI for **FORCE/FINES**. Efforts to clarify funding modalities and criteria are hampered by an unclear division of tasks with other stakeholders and a poor match between the SNSF's portfolio and competencies and the requirements of infrastructure funding: Whereas SNSF funding policy revolves around recurrent competition based on scientific quality, infrastructure funding requires long-term decisions based mainly on strategic considerations.

Looking ahead: suggestions for future SNSF funding of research fields and infrastructure

The SNSF concludes that:

- **The responsive mode should remain the main funding mechanism of the SNSF and project funding the principal funding scheme.** The large budget share free of topical, strategic or institutional constraints clearly distinguishes the SNSF from most other funding agencies worldwide, very likely ensures its effectiveness and may contribute to the country's excellent standing in research.
- **The SNSF should invest pro-actively in research domains only where a clear need for a special incentive has been identified and where universities or federal departments alone cannot act effectively**. Such investments should generally be integrated into the multi-year planning, following active foresight.
- **The SNSF should not try to integrate very large initiatives like SystemsX.ch or Nano-Tera into its portfolio**. If such initiatives prove to be necessary, the SNSF should be involved early on in the set-up process.
- **Whether the SNSF should offer an additional scheme in the responsive mode for medium sized consortia remains to be resolved.** Sinergia and its interface with project funding and the NCCRs are currently being examined in view of potential synergies and improvements.

- **Infrastructure grants must be compatible with the principles of competitive funding.** The SNSF should fund only infrastructures that are required on the basis of specific scientific issues and with a time-limited financial commitment. It would welcome a Swiss-wide infrastructure budget and process.

2. Task commissioned by the SERI

Background and context
The funding organisations enshrined in the Research and Innovation Promotion Act (RIPA) are subject to periodic evaluations commissioned by the Swiss Confederation. It is a good ten years since the SNSF was last subjected to an overall evaluation, with the result that the SERI assigned the Swiss Science and Technology Council (SSTC) in March 2013 with the task of carrying out such a review. This self-evaluation report from the SNSF is commissioned by the SERI as the basis for the evaluation and assessment to be carried out by the SSTC.

As the foundation for its strategic planning for the period 2017 to 2020, the SNSF adopted its own evaluation concept in 2011, in which it makes a distinction between the three different levels (a) *funding agency*, (b) *funding policy* and (c) *funding schemes.* Evaluations of the SNSF as a funding agency (a), as in the case of this current evaluation by the SSTC or the previous institutional overall evaluation, are the responsibility of the Swiss Confederation and are conducted on its behalf. Levels (b) and (c) in contrast, relate to tasks that the SNSF essentially performs autonomously and for which the SNSF itself is responsible. Correspondingly, the SNSF itself is responsible for launching evaluations in these areas, as was recently the case with the evaluation of the selection procedure by Chris Coryn in 2012[1] and also the client survey drafted by the *Nordic Institute for Studies in Innovation, Research and Education*, which was primarily aimed at project funding and Sinergia and was designed to test planned changes to these funding schemes[2]. The effectiveness review of the National Centres of Competence in Research (NCCRs) also continues, commissioned by the SERI.

Scope of the evaluation
The SSTC's evaluation and the SNSF's self-evaluation report focus on the systematic level and two issues that are critical to the future direction of funding policy, namely the role of the SNSF in funding research infrastructures and its role in the development/funding of specialist fields.

In its 2012-2016 multi-year programme, the SNSF writes: "It is a fundamental aspect of the SNSF's role in research policy that we support researchers and their ideas, not structures and topics. It is the researchers who know best how to shape research in order to obtain new findings. For this reason, the SNSF will continue over the coming years to use competition and high quality standards to promote excellence in Swiss research, without setting priorities in terms of research content." At the same time, the SNSF also supports the particular **needs of individual research fields** on a case-by-case basis. This was the goal, for example, between 1999 and 2011 of the DORE funding programme, focusing on the research areas of health, social work and art at universities of applied sciences and universities of teacher education, and it also applies to initiatives in Biology

[1] Coryn, C. L. S., Applegate, E. B., Schröter, D. C., Martens, K. S., & McCowen, R. H. (2012). *An evaluation of the transparency and overall quality of evaluation at the Swiss National Science Foundation: Final report.* Kalamazoo, MI: Western Michigan University, The Evaluation Center.
[2] Report available in February 2014

and Medicine. Through evaluation mandates, the SNSF is involved in the major initiatives SystemsX.ch and Nano-Tera.ch. These present it with the challenging task of reconciling targeted funding to meet specific needs with open competition for funding.

In this regard the SERI's evaluation mandate includes the following questions (mandate text):

- With regard to which critical aspects (e.g. expansion of scale, cost development, funding efficiency, critical mass/concentration) and challenges (e.g. reconciling national and international funding schemes) does the SNSF's funding policy, which has basically been "reactive" to date, come up against limitations? Do specific challenges, e.g. in conjunction with the question of developing/strengthening new specialist areas in Switzerland or the question of Switzerland's international cooperation/integration require a more active management (setting of priorities) of funding policy by the Research Council?
- How should the details of such a "funding policy" be fleshed out? Using which tools and on what evidence base could such a policy be developed in the Research Council? Using which (established or new) tools and to what extent could or should the policy be implemented by the SNSF itself? What would be the consequences for other stakeholders (community, higher education institutions, backers, federal government)? What would be the risks for the further development of national research and innovation funding?

The requirements of the specialist areas often relate to **infrastructure.** Consequently, the second subject of the evaluation is closely linked to the first. Research infrastructures are increasingly becoming a key prerequisite for the advancement of knowledge and thus the development of specialist fields in many scientific areas. At the same time, they also require a long-term financial commitment. This requires sound coordination among the stakeholders (academies, higher education institutions, SERI, SNSF), as is the aim with the research infrastructure roadmaps being devised at national and European level. As far as the SNSF is concerned, long-term financial commitments present a challenge for a funding policy that is essentially demand-oriented and competition-based.

In this regard the SERI's evaluation mandate includes the following questions (mandate text):

- Has the SNSF's funding activity to date basically proved its worth? Where and in what form have major "typical" problems or even "systemic problems" arisen?
- From the SNSF's perspective, what are the main medium and long-term challenges associated with consistent funding practice? What are the consequences with regard to developing specialist fields in Switzerland within the SNSF's remit?
- Does the SNSF intend to make adjustments to its existing funding practice and, if so, what kind of adjustments? What will be the repercussions for other stakeholders (federal government, cantons, higher education institutions) in terms of supporting/financing research infrastructures?

Explicitly **excluded** from the scope of the evaluation following agreement between the SERI and the SNF are the internal organisation and functioning of the SNSF, the funding schemes per se, the promotion of young researchers per se, the role of the SNSF in the changing world of higher education, cooperation between the SNSF and CTI, and the NCCRs.

Structure of the report

Section 3 sets out the current policy of SNSF funding in general. In sections 4 and 5, the current modes of funding of research fields and of infrastructures are explained, respectively. Case studies are included and conclusions are drawn. Sections 3 to 4 are based on comprehensive data.

Whereas the most important figures are presented as tables or diagrams directly in the text sections, most of the data is contained in tables in several annexes (section 7). In sections 4.8 and 5.5 current funding of research fields and of infrastructures are reviewed critically whereas section 6 broadly outlines the future policy proposed by the SNSF concerning these two topics.

Methods and data base
The data base for this report comprises the application and project data from the SNSF for the period from 2008 to 2012 (for further details see appendix 7.1), as well as the higher education statistics from the Swiss Federal Statistical Office for the estimation of the share of researchers covered by the SNSF (Appendix 7.2), and Pubmed publication data for portfolio analysis based on topic modeling (Appendix 7.3). The Case Studies on infrastructure funding and initiatives in different research fields are based on written surveys of the SNSF employees with responsibility for the fields in question.

3. General characteristics of current SNSF funding

3.1. Legal framework

As a research funding organisation pursuant to the RIPA, the SNSF performs the following tasks based on its Statutes as approved by the Federal Council:

- The SNSF **promotes scientific research** in Switzerland. It promotes the **international competitiveness and integration** of this research as well as its **capacity to solve problems**. It pays particular attention to the promotion of **young researchers**.
- The SNSF awards funds primarily on the basis of **scientific quality** criteria. In addition, it considers the **specific needs of the disciplines**. All disciplines are equally valued. There is no entitlement to funding.
- SNSF funds may **not** be used for research with an immediate **commercial purpose.**

With its portfolio of funding schemes, the SNSF aims to address these different objectives. Eligibility and criteria are documented in the SNSF's Funding Regulations or in **specific calls**. Since both NRPs and NCCRs are of high political relevance, their main objectives and procedures are also enshrined in the **RIPA**. The SNSF is responsible for infrastructure funding subsidiary to the research centres of the higher education institutions and the Confederation. In matters relating to the Swiss roadmap for research infrastructures and as part of the European Strategy Forum on Research Infrastructures (ESFRI), the SERI can mandate the SNSF to finance research infrastructures in particular subject areas and specialist fields. According to the RIPA and its statutes, the SNSF may also accept **evaluation mandates** from the Confederation or from third parties, as is the case with SystemsX.ch or Nano-Tera.ch, if they do not interfere with the execution of its main tasks. In addition, the SNSF contributes to covering indirect research costs (overhead).

3.2. Modes of SNSF funding

At the core of the portfolio, **project funding** including interdisciplinary projects stands for the responsive, researcher-driven funding mode. It is open to all research topics and disciplines and has no specific requirements concerning the structure or format of projects. Scientific quality is the only criterion for the allocation of funds. From the researchers' point of view, the funding opportunities remain responsive both thematically and in terms of needs. Since 2008, Sinergia has enabled small consortia to submit joint project proposals and to include a research group from

outside Switzerland. As structure and format are strongly pre-defined, Sinergia could in principle be classified as a programme (see below).

Career funding offers support to young researchers at various stages in their careers. It is thematically open but caters for the specific needs of researchers, from doctorate to assistant professorships, including structural conditions as appropriate. For instance, fellowships are awarded for research stays abroad.

Funding **Programmes** have pre-defined thematic or conceptual/organisational parameters.

- ***International co-operation programmes*** promote co-operations between researchers in Switzerland and abroad. They are mostly thematically open but focus on certain priority countries, where they aim to strengthen research capacities, promote the institutional development of research and improve integration into the international scientific community.
- With the ***National Centres of Competence in Research (NCCRs)***, the SNSF and the federal authorities aim to strengthen research structures in fields of strategic importance for the future of Swiss science, the Swiss economy and Swiss society, building up international competitiveness. Calls may be thematically open or specified, but in either case the selection of an NCCR will thematically determine funding for over a decade.
- ***National Research Programmes (NRPs)*** are designed to make scientific contributions towards solutions to pressing problems of national importance, whether they relate to society, politics or the economy. Although themes are initially proposed by researchers and evaluated by the SNSF with regard to scientific quality and feasibility, the topics are ultimately specified by the Federal Council on the basis of political priorities.
- ***Longitudinal studies in biology and medicine*** (formerly called cohort studies) receive long-term support for the establishment of population based data collections for research purposes. They are mostly run by multisite consortia and research networks, and their data and/or samples are open to researchers active in the same field. Longitudinal studies may be run in any research field, provided that there is genuine research interest which motivates the establishment of a longitudinal study and that it is of public health interest. As a large part of the funding budget is in fact dedicated to infrastructural costs, the longitudinal studies are classified as such in this report. Research projects embedded in such studies are financed via project funding.
- ***The Swiss Clinical Trial Organisation (SCTO)*** is a central cooperation platform for patient-oriented, clinical research in Switzerland, and was founded by the SNSF in collaboration with the Swiss Academy of Medical Sciences (SAMS). Today the SCTO is an independent organisation receiving infrastructure funding for its operations, such as definition of quality standards for the conduct of studies, continued education and training, positioning Swiss clinical research at the national and international level, as well as for the coordination of the main operational network of **Clinical Trial Units (CTU)** located at the five University Hospitals Geneva, Lausanne, Berne, Basel, Zürich, and the Cantonal Hospital of St. Gallen. The set-up and development of CTUs at University and Cantonal Universities was also an earlier infrastructure funding initiative to enhance high quality patient-oriented clinical research in Switzerland. This initiative was restricted to a unique funding period of five years for the set-up phase, which has been concluded in the meantime, and will not be further commented on herein.
- In the natural sciences, humanities and social sciences, the SNSF funds **long-term projects**, whose lifetime may cover several decades, which implies significant funding for the research fields benefitting from the funds: experimental physics, chemistry, astronomy, astrophysics

or climate research in the **natural sciences**, long-term funding for publication projects, edition projects, legal sources or dictionaries, which are, according to many definitions, considered as infrastructures, in the **humanities**.

Research infrastructure: the SNSF currently funds infrastructures in various contexts.

- ***R'Equip*** provides funding in all scientific fields for the procurement and development of research equipment.
- Under the title **'Forschungsinfrastrukturen'** the SNSF contributes to coordination services for research initiatives, such as the Swiss Clinical Trial Organisation, or the costs of setting up or running research structures, platforms or portals, for example the European Social Survey or the Survey of Health, Ageing and Retirement in Europe, both included in ESFRI.
- ***FORCE* and *FINES*** allowed Swiss scientists access to international infrastructures in the fields of particle physics at CERN, resp. astronomy at the European Southern Observatory; in 2012, they were subsumed under the new programme **FLARE**, which also addresses astroparticle physics.
- As mentioned above, in the **humanities**, and to a lesser degree in the social sciences, the SNSF funds **long-term projects** (most of them publication projects, edition projects, legal sources and dictionaries) which are, according to many definitions, considered as infrastructures but currently financed via the project budget.
- With the **longitudinal studies in biology and medicine** and the initiative for the **CTU** described above, the SNSF, too, provides infrastructure funding.

Table 1 provides an overview of the overlap between infrastructure funding and funding of research fields.

Scheme	Infrastructure funding	Funding research fields	Budget line	Section of report
R'Equip / Forschungsinfrastrukturen	yes	no	Infrastructure	5
FORCE / FINES / FLARE	yes	to some extent	Infrastructure (additional contribution)	5
Initiatives for research in biology and medicine	yes	to some extent	Programmes	4.5.2
Long-term projects humanities	yes	to some extent	Projects	4.5.4
Long-term projects natural sciences	in certain cases	yes	Projects	4.5.3

Table 1: Infrastructure funding and funding of research fields

Figure 1 situates funding schemes generally with respect to their thematic focus and/or focus on specific structures/formats, of which infrastructure funding may be one manifestation. The bubble size, which reflects share of total spending between 2008 and 2012, emphasises the significance of responsive-mode schemes in the bottom-left field (in particular project funding).

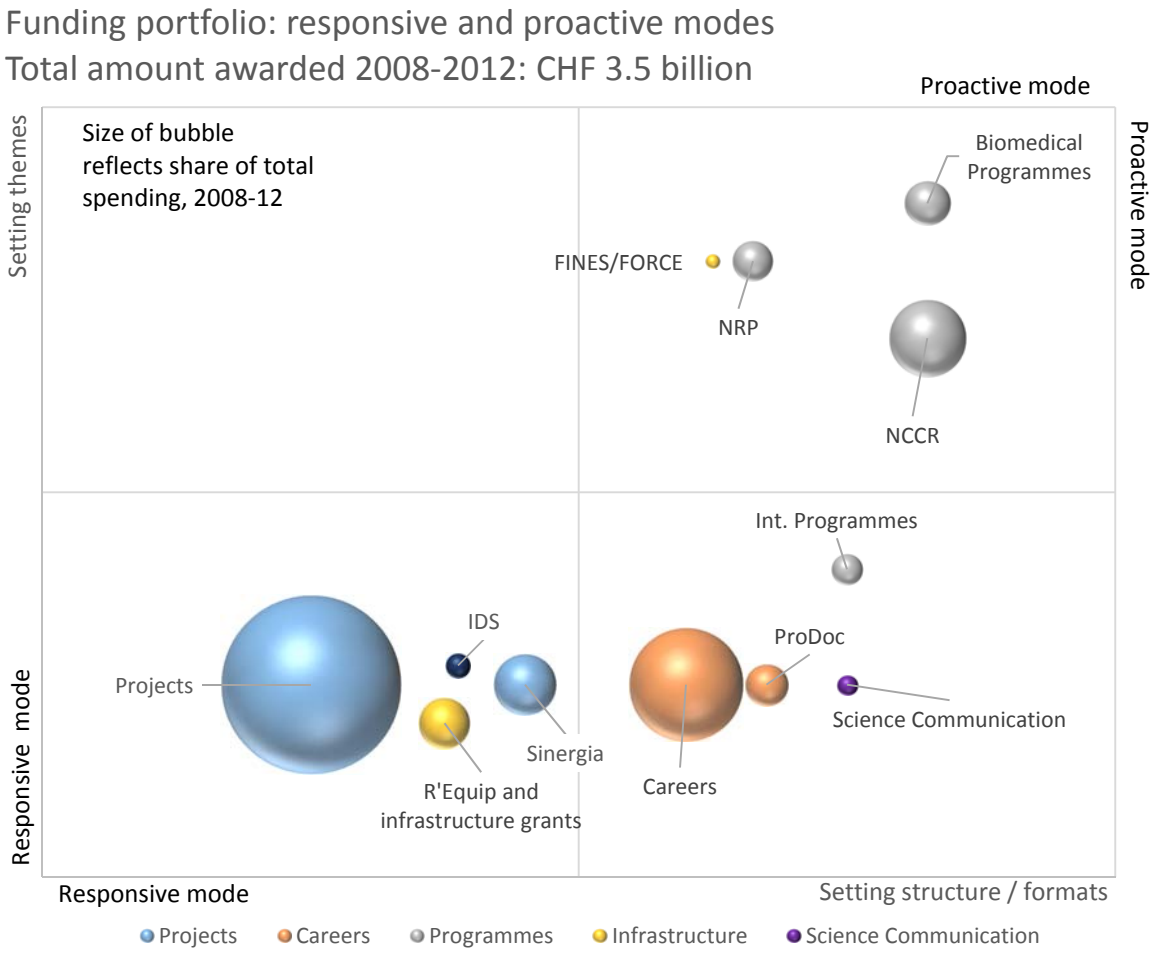

Figure 1: Nature of the various funding schemes, excluding external evaluation mandates SystemsX and Nano-Tera.

Scheme	Amount awarded 2008-2012 (CHF)	Share of total funding
Project funding including interdisciplinary research (IDS) and DORE	1'809'972'300	51%
Sinergia	205'219'671	6%
Career funding including ProDoc	814'104'647	23%
International co-operation programmes	48'793'106	1%
National Research Programmes	86'586'150	2%
National Centres of Competence in Research	324'398'403	9%
Programmes for research in biology and medicine including longitudinal/cohort studies, CTU and SPUM	107'601'895	3%
Infrastructure funding including R'Equip, Force and Fines	146'674'820	4%
Science communication	20'581'018	1%
Total	**3'563'932'010**	**100%**

Table 2: Amount awarded and share of total funding per funding scheme.

4. Research fields: characteristics of current funding

4.1. Responsive mode - overview

At the core of the SNSF's portfolio, two funding schemes offer researchers funding opportunities to follow up on new ideas and implement research projects in all disciplines and on all topics: project funding, the SNSF's main funding scheme, and Sinergia for small networks.

Project grants cover direct research costs associated with a research topic or a line of research for a period of up to three years (one three-year follow-up is possible), including staff salaries, materials and infrastructure but excluding the principal investigator's salary. They are open to researchers at Swiss research institutions who have at least two years of postdoctoral experience and are in a position to perform research independently. Thus, project funding aims to support freedom of research, offer equal opportunities for public funding and provide researchers with a certain independence from host institutions.

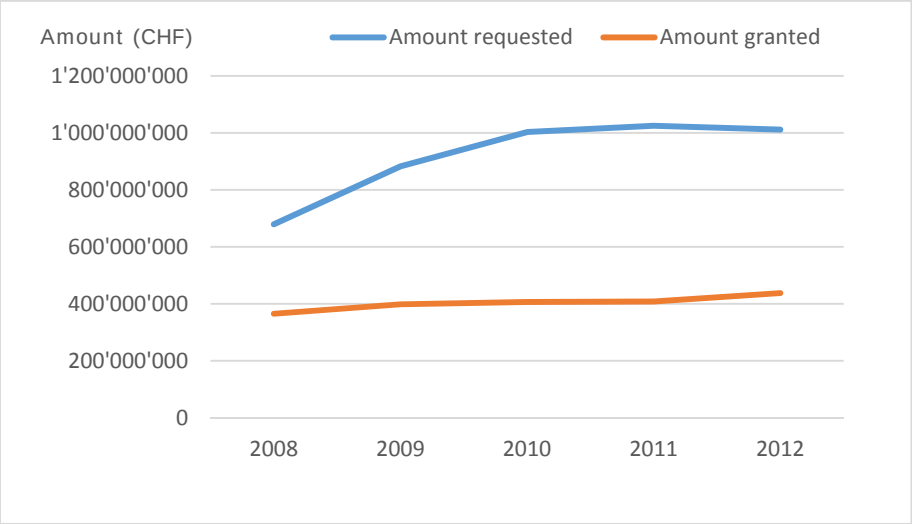

Figure 2: Project funding and Sinergia.

In line with the Service Level Agreement with the federal authorities, which aimed to reinforce project funding as the backbone of SNSF funding, the amounts granted for projects increased from

CHF 352 million in 2008 to CHF 391 million in 2012. Nevertheless, their growth was not sufficient to compensate for the rapid increase in demand witnessed especially at the beginning of the period. Factoring in the new funding scheme Sinergia, introduced in 2008, the amounts awarded increased by 4.6% per year on average, versus a 10.5% increase for amounts requested.

With Sinergia, the SNSF aims to promote scientific research that requires a synergetic approach in order to answer novel scientific questions. It funds inter-, multi-, uni-disciplinary research involving 3 to 4 groups of scientists. 80% of the scientists submitting grant applications for Sinergia have also submitted proposals in project funding. In the case of Sinergia, they mainly propose new collaborations: about 60% of the Sinergia consortia applied jointly for a grant for the first time. 30% of the Sinergia networks had already submitted other proposals to the SNSF, while 10% were resubmissions of rejected SystemsX.ch or Nanotera.ch proposals.

A further similarity between project funding and Sinergia is the level of individual funding. Sinergia funds small networks with about CHF 1.3 million each. Each of the 3 to 4 groups in a Sinergia

project, however, is funded at a similar level as they would be in project funding (about CHF 117,000 per year).

With over CHF 2 billion, project funding and Sinergia together made up for 57% of the total spending between 2008 and 2012. They are the main funding schemes in the responsive mode. Factoring in career funding (excluded from this report) and infrastructure funding (separate section of this report), the share of spending open to all disciplines and research topics, with scientific quality as the only criterion for the allocations of funds – eligibility for funding assumed – increases by another CHF 950 million to 83% of the entire SNSF budget in the period concerned. Since career funding remains outside the scope of the evaluation, the following chapters focus on project funding and Sinergia[3]

4.2. Reponsive mode – funding by research field / discipline

Figure 3 shows the fields of research to which project funding and Sinergia funds flowed between 2008 and 2012, based on the discipline groups specified by researchers at the time of application. Interdisciplinary research is included and attributed to the major research discipline.

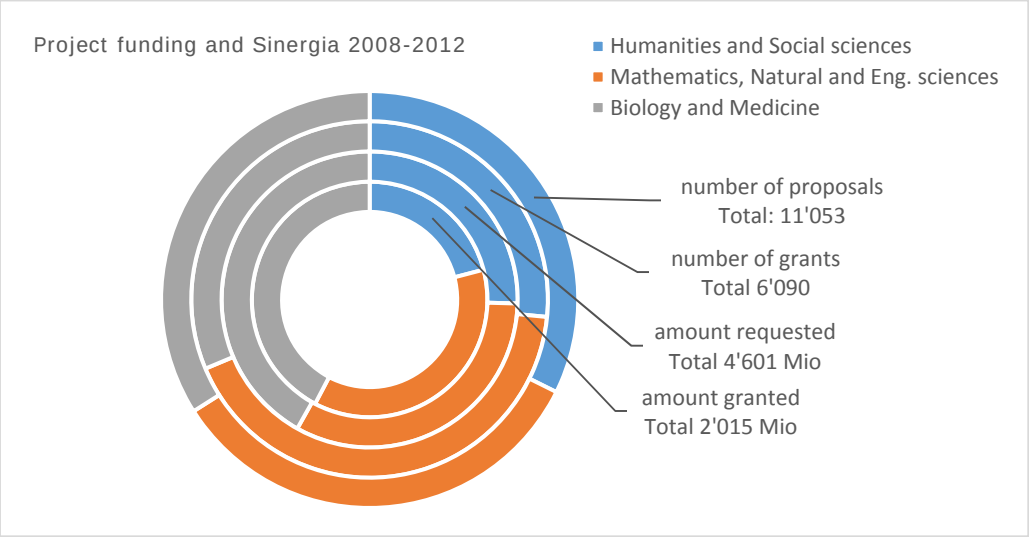

Figure 3: Offer and demand by division.

Amounts awarded (and requested) in the humanities and social sciences are lower than in other fields, notwithstanding similar numbers of applications. Around one fifth of the amounts awarded went to the humanities and social sciences, just under 40% to mathematics, natural sciences and engineering and just over 40% to biology and medicine.

At the level of discipline groups, the largest amount of funds was awarded and requested in basic biology (301). In terms of the number of grants, engineering sciences (205), legal and social sciences (102) and basic biological research (301) account for the highest numbers. Although differences between the number of grants and the amounts requested are likely linked in part to differences in cost between research fields, solid evidence in this respect is lacking, since researchers may cover only part of their project costs with SNSF funding and adapt the amounts requested to the amounts they expect the SNSF to fund.

[3] The categorisation of funding schemes corresponds to the nomenclature applicable to SNSF annual reports since 2011, where project funding includes interdisciplinary projects, long-term applications and DORE.

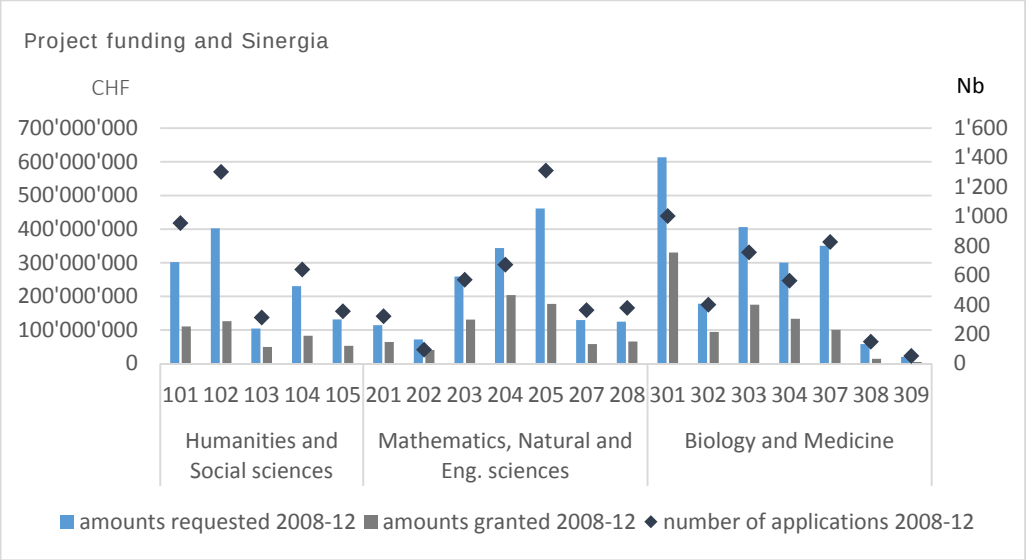

Figure 4: Offer and demand by discipline group.

Amounts awarded followed amounts requested in a linear fashion between 2008 and 2012. Only general biology (302), where amounts awarded increased faster than amounts requested, as well as the smaller discipline groups of social medicine (309) and preventive medicine (308) did not fit this pattern. This suggests that the SNSF was, during the period 2008-2012, overall well able to adapt to changing demand. The fastest growing field, both in terms of amounts requested and granted, was astronomy, astrophysics and spatial sciences (202).

4.3. Responsive mode - grant size

For projects, the average funding per year (spending level) increased from approx. CHF 112'000 in 2008 to CHF 122'000 in 2012. It was lower than average (around CHF 100'000) and rather homogenous in the discipline groups of the humanities and social sciences. The spending level varied most strongly between the discipline groups of mathematics, natural and engineering Sciences, ranging from just above CHF 100'000 in mathematics, to over 250'000 CHF in astronomy, astrophysics and spatial sciences. This reflects a particular practice in high energy physics and astronomy, where entire institutes may submit collective grant applications within project funding. Within the Biology and Medicine division, the spending level was highest for basic biological sciences (approx. CHF 156'000) and lowest for social medicine (ca. CHF 104'000). The fact, however, that researchers can be involved in several research projects may raise their SNSF spending level significantly. In addition, the spending level is determined by several parameters such as discipline, ranking of the proposal, researchers' strategy, co-funding situation and SNSF evaluation practice.

Spending level granted was at around 85% of spending level requested across all discipline groups (Figure 5) and throughout the period under analysis. Both spending level requested and granted remained rather stable, with spending level granted rising slightly faster, at 2.3% a year on average, against 1.8% for spending level requested. No clear pattern is discernible in the evolution of spending level granted and requested per discipline group.

Humanities and Social sciences	
101	Philosophy, Psychology, Educational science and Religious sciences
102	Legal and Social sciences, Geography, Economics
103	History
104	Archaeology, Ethnology, Arts
105	Linguistics and literature
Mathematics, Natural- and Engineering sciences	
201	Mathematics
202	Astronomy
203	Chemistry
204	Physics
205	Engineering (informatics)
207	Environmental sciences
208	Earth sciences
Biology and Medicine	
301	Basic Biology
302	General Biology
303	Basic medical sciences
304	Experimental medicine
307	Clinical medicine
308	Preventive medicine
309	Social medicine

Table 3: Disciplines by division[4]

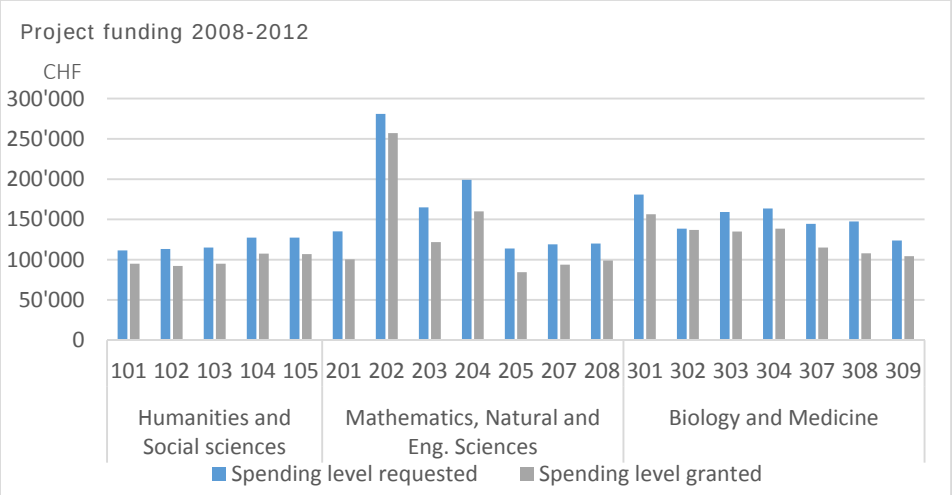

Figure 5: Spending level requested and granted in CHF.

Between 2008 and 2013, the total number of proposals submitted in a Sinergia call for projects increased by 11% while its requested budget decreased. The latter is an artefact of the amendment of the regulations decided in 2012: the number of sub-projects was limited to a maximum of four in order to avoid large consortia whose financial needs could not be met, given the annual budget of CHF 50 million

[4] The discipline groups correspond to an aggregation of 117 disciplines. For further details see http://www.snf.ch/SiteCollectionDocuments/allg_disziplinenliste.pdf. For instance: social sciences include sociology, political sciences, social geography and communication sciences.

Year	Number	Inter-disc.	HSS	MINT	Life sciences	Avg. requested funds
2008	18	7	0	12	6	1'673'614
2009	88	36	17	33	38	1'655'844
2010	90	37	23	24	43	1'688'041
2011	90	32	19	20	51	1'628'973
2012	92	47	18	29	45	1'584'867
2013	98	53	21	34	43	1'540'411
Total	**476**	**212**	**98**	**152**	**226**	**1'620'039**

Table 4: Average requested funds between 2008 and 2013.

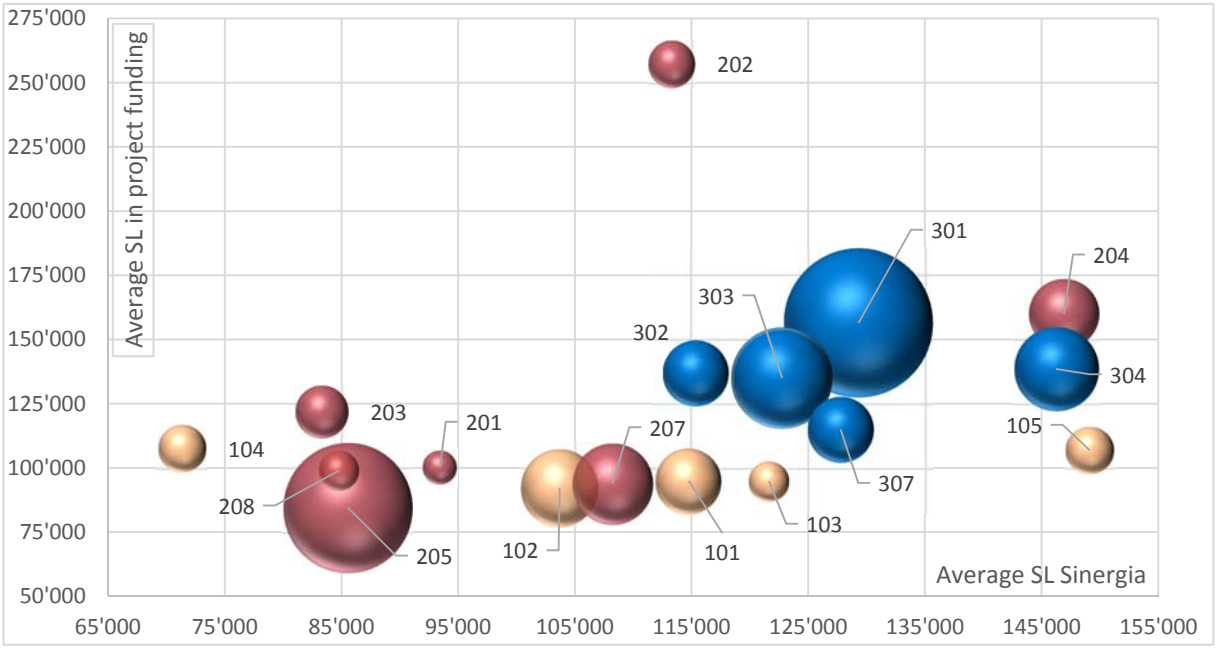

Figure 6: Average spending level in project funding versus Sinergia.

The scheme is particularly popular in the Life Sciences. Indeed, more than half (225) of the proposals (476) involve a main discipline in thisSiner domain. Sinergia grant size can only be reasonably compared with that of individual grants at the level of sub-projects (3-4 per Sinergia grant). A meaningful comparison is not possible for 2008, because in the first call the definition of subprojects and groups was neither clear nor limited. The results for 2009-2012 show (Figure 6) that the requested and allocated spending level of Sinergia subprojects are largely in the same range as for individual projects (CHF 141'000 and CHF 114'000, respectively).

4.4. Responsive mode - SNSF funding and clientele within the Swiss research landscape

4.4.1. Funding by institutions

Almost two thirds of project and Sinergia funds went to the Cantonal Universities. Roughly 30% went to the ETH Domain, the remainder was shared between the universities of applied sciences and teacher education and various other institutions (private companies, hospitals…). The yearly amounts attributed to the Universities of applied sciences (UAS) and of teacher education (UTE) increased between 2008 and 2011, to decrease in 2012, when the funding scheme DORE was

integrated into project funding. Nevertheless, the funds which went to the Universities of applied sciences and teacher education rose more than the average for project funding and Sinergia during 2008-2012 (5.7% versus 4.6% on average). In addition, the UASs and UTEs increased their participation in the NRPs, international programmes, SNSF professorships and Ambizione. Applications to the SNSF from these institutions come mainly from the humanities and social sciences.

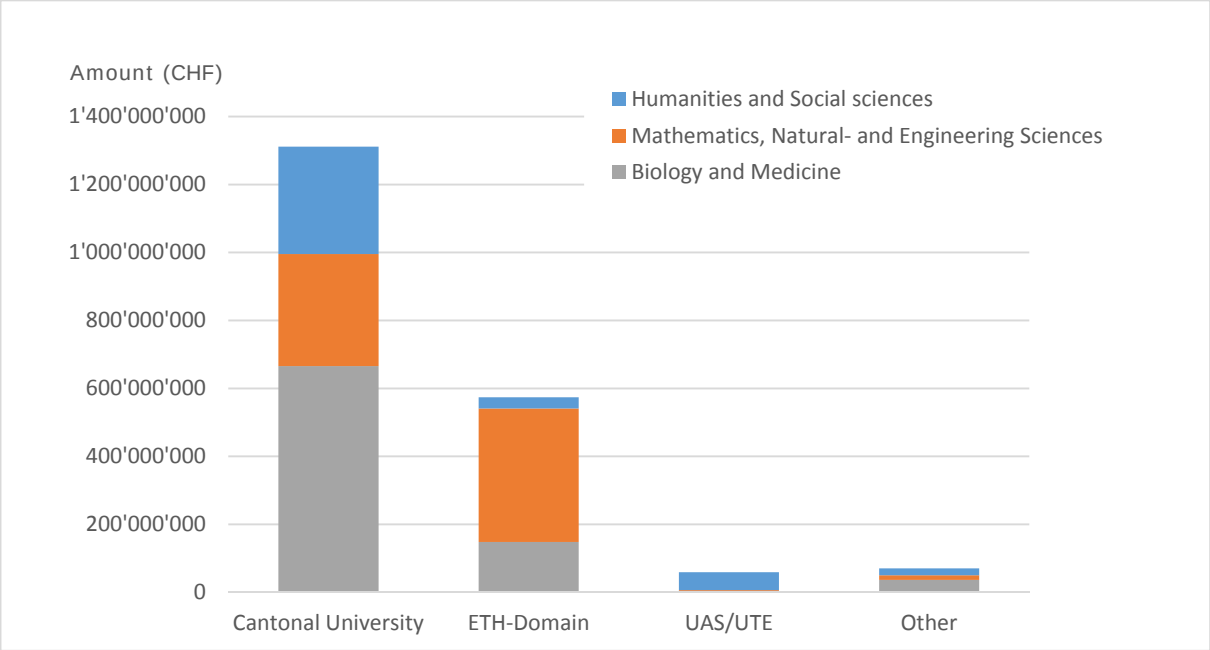

Figure 7: Amounts awarded by institution type and research field between 2008 and 2012.

4.4.2. SNSF coverage of university researchers in Switzerland

The SNSF is only one of several funding sources for researchers in Switzerland, along with institutional funding, public funds allocated directly by governmental authorities, the EU Framework programmes or private funds. Overall, SNSF funding accounts for approx. 15% of research funding at Swiss universities.[5] In 2011, around 30% of researchers employed at the Universities, the ETHZ and the EPFL submitted a project proposal to the SNSF, or were benefitting from an ongoing grant. The analysis includes project funding including interdisciplinary projects and Sinergia.

The coverage was consistently high - above 50% - for mathematics, natural and engineering sciences, highlighting a strong tradition for drawing on SNSF funds in these fields of science. Coverage was lower in the humanities and social sciences, with a noticeably higher number of researchers and a somewhat lower number of SNSF customers than in the two other fields. Coverage was also more heterogeneous – ranging from under 10% in economics, law and architecture, to over 40% for history and sociology, which reflects the diversity of research traditions and alternative funding opportunities within the humanities and social sciences. Biology and medicine was in the middle range with around 40%. Statements about differences within the field are difficult since data for the number of researchers is available only for the two categories of biology and medicine and biomedical research is thus difficult to situate.

[5] 2011 Kosten der Universitären Hochschulen 2011, Federal Office of Statistics, http://www.bfs.admin.ch/bfs/portal/de/index/themen/15/06/data/blank/04.Document.166255.xls

This highlights one of many limitations of the analysis, which are detailed in Annex 7.2. The discipline categories applied by the Federal Statistical Office (FSO) for researcher data reflect institutional affiliation rather than research portfolios. The equivalence between the discipline groups used by the FSO to categorise researcher data and the SNSF's categorisation of its grant portfolio are problematic especially for multidisciplinary or interdisciplinary research. Errors diminish at a higher level of aggregation. The somewhat heterogeneous level of aggregation of the discipline groups in Table 5, devised to match the FSO's and SNSF's categorisations, is the result of the varying alignment between SNSF and FSO categories and attempts to maximise the level of detail while reducing biases. Approximately 5% of researchers could not be matched with SNSF categories and were not included in the estimation of coverage. The second major source of error is linked to the definition of potential applicants for SNSF funding. The universities' personnel categories are broad and heterogeneous, so that the chosen inclusion criteria may not be the best approximation for all institutions.

A similar analysis of the proportion of researchers at the universities of applied sciences and the universities of teacher education submitting proposals to the SNSF would be valuable but is not feasible with the available data. The discipline categories used by the Federal Statistical Office for these institutions are difficult to match to SNSF categories. An even greater impediment is the absence of reliable data on the personnel active in research and in a position to submit proposals to the SNSF.

Discipline	Number of researchers Universities, ETHZ, EPFL	Number of SNSF customers	Coverage
Humanities and Social Sciences	***7952***	***1235***	***16%***
Humanities	**1008**	**314**	**31%**
Philosophy	129	50	39%
Theology	277	52	19%
History	287	117	41%
Archaeology, prehistory, ancient history and classical studies	89	46	52%
Ethnology	101	28	28%
Musicology, theatre and cinema	91	21	23%
Other humanities	34		
Educational science, psychology, sociology, political science, communication science	**1815**	**442**	**24%**
Educational science and psychology	907	264	29%
Sociology	191	82	43%
Political science	268	64	24%
Communication sciences	175	32	18%
Social sciences other	274		
Economics	**2073**	**155**	**7%**
Legal sciences	**1017**	**85**	**8%**
Geography	**215**	**40**	**19%**
Art history, architecture, planning, social urban science	**437**	**59**	**14%**
Linguistics and literature	**1246**	**140**	**11%**
Other humanities and social sciences	141		
Mathematics, Natural and Engineering Sciences	***2508***	***1515***	***60%***
Mathematics	**269**	**146**	**54%**
Physics, astronomy, astrophysics and spatial sciences	**457**	**348**	**76%**
Chemistry	**334**	**210**	**63%**
Engineering sciences	**815**	**485**	**60%**
Earth- and environmental sciences	**579**	**326**	**56%**
Other natural and engineering sciences	54		

Biology and Medicine	***5053***	***2014***	***40%***
Other	***428***		
Total	**15941**	**4764**	**30%**

Table 5: Funding coverage by discipline (2011).

4.4.3. Topic Modeling – Research in biology and medicine

As described above, one of the main limitations when estimating the coverage of the scientific community by the SNSF arises from the different definitions of disciplines. We therefore aimed at complementing the ad hoc mapping of institutional discipline lists with a common list of scientific themes based on the semantic content of publications and grant applications. We focused on scientific areas where the researchers' counting is the least reliable: life sciences. Topics describing diseases, biological entities or methods were defined by applying non-supervised machine learning technics called Topic Modeling, or Latent Dirichlet Allocation on a representative set of projects.

We apply two proxys to approximate the coverage of the Swiss community of independent researchers in biomedical research by the SNSF. First, the research activity in Switzerland is approximated with original publications indexed by Pubmed whose corresponding author is affiliated to a Swiss institution. Second the SNSF funding activity is approximated by the number of projects submitted in biomedical research, their requested and allocated funding. This method also has significant limitations, explained in the appendix. Yet, it forms an interesting complement to the researchers' counting presented above. Indeed, it is exclusively based on texts produced by researchers and bypass their institutional situation. A model can be trained iteratively at different intervals of time or include the dynamics of the topics. It can therefore provide a tool to monitor the evolution of topics, their emergence or disappearance. This approach is not restricted to any scientific field. It goes beyond current partial document classifications like Compendex or MESH and can dynamically include interdisciplinary research

A model fitting a representative dataset is trained. To obtain both a good semantic fit to the data and a good interpretability of the trained topics in biological terms, we considered a categorisation made of 200 topics. Each single topic is modeled in an automatic fashion. It is formed by a distribution of words. Its interpretation, however, necessitates a human intervention. Topics can be interpreted for instance as diseases, biological entities or methods.

The result of such semantic modeling is twofold. First, it gives a thematic representation of publications and SNSF projects. It is a first step towards the definition of coverage indicators. Second, it reduces the semantic complexity of these documents and enables the estimation of semantic similarities between them.

In this pilot phase, we used the number of publications as an indicator for the research activity. The analysis of the SNSF coverage of this community is done by comparison with the number of submitted projects, their requested and allocated budget.

The analysis basically results in an exploration tool. The corpus of Swiss publications and SNSF projects can be browsed. Documents with the same thematic content can be compared and discrepancies between the scale of occurrences of particular topics in publications and projects can be explored. The tool's screenshots are displayed in the chart below. It shows several artefacts. Scientific disciplines as indexed by publication database are not consistently aligned with the SNSF internal organisation. Pubmed can index publications containing topics in engineering, chemistry or physics when relevant for health issues. With the SNSF, the corresponding proposals are mainly submitted in Division II. They could therefore not be included automatically in the current analysis. This is the case for the following topics.

Topic ID	30	31	69	90	150	163
Content	Statistical methods	MRI	Chemistry	Nano-parti-cles	Structure imaging	Mass Spectrometry

Differences in the publication cultures in the life sciences can explain the presence of other outliers. For instance, clinical research produces more publications. Some of them can for instance be case reports. It is questionable to what extent these have the same scientific value as research articles. This is in particular the case for topics 23 (Surgery), 29 (Patients), 37 (Treatments) and 55 (Clinical trials).

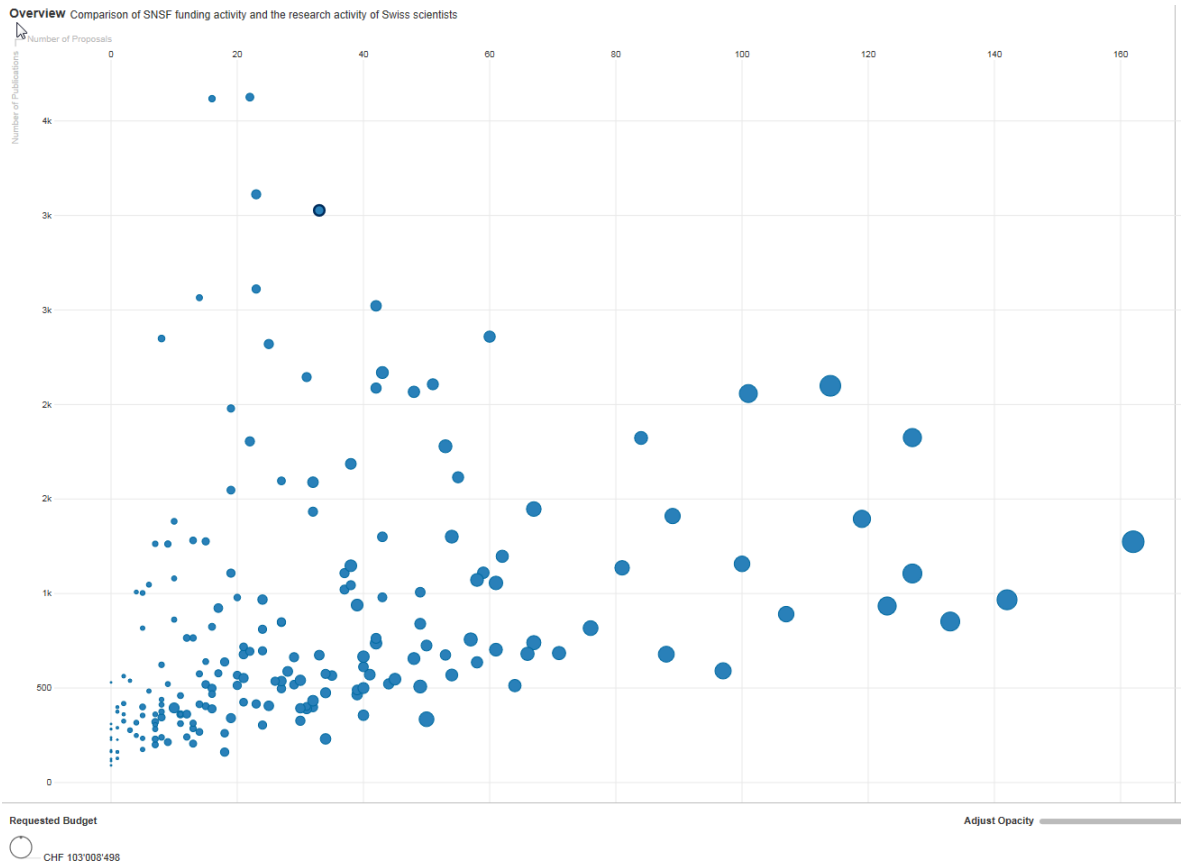

Figure 8: SNSF funding activity versus research activity of Swiss scientists.

After excluding the organisational artefacts, we observe a diverging phenomenon. For a given research activity, the number of submitted projects or the amount of the requested budget can differ considerably. For instance, we can compare the research activity in three different topics: microbiology, infectiology and biology using models like drosophila, yeast or *C. Elegans*. In the period 2008-2012, these topics were present in approximately the same number of publications (~2000). Yet, the SNSF received 119, respectively 89 and 67 projects containing these topics in the same period of time. In medicine, there were as many publications in gynaecology as on heart diseases (approx. 1300 publications). Yet, 101 SNSF proposals spoke about heart disease while 59 contained gynaecology/pediatry (requested budget of CHF 25 million vs. CHF 50 million). These two cases exemplify a divergence between the research activity and the need for monetary demand as observed by the SNSF.

4.5. Pro-active mode – case studies

In several cases the SNSF funded certain research fields or research communities in the proactive mode.

4.5.1. DORE

At the time of Switzerland's universities of applied sciences (UASs) being established (from the mid-1990s onwards), the introduction of an extended remit, also conferring responsibility for research on these institutions, was a central element. Whilst use-inspired research was already being conducted in the subject areas of technology, business and design, research expertise first of all had to be built up in the areas of health, social work and art[6]. With this in mind, the SNSF and the Commission for Technology and Innovation (CTI) launched their joint initiative DO REsearch (1999-2003) in order to support the development of research in these areas. As of 2004 the SNSF began running the DORE programme itself, as it became clear that, while the research projects were indeed focusing on practical issues, the results tended to be geared towards a general gain in scientific knowledge rather than market-oriented product development. Additionally, the researchers were focusing their output on academic publishing in order to make their research expertise highly visible. This meant that the research being carried out at the UASs in these fields had more in common with the SNSF's funding activities than with the CTI's. By launching this initiative, the SNSF was also building a bridge in research funding between purely basic research (generally SNSF-financed) and applied research (generally CTI-financed).

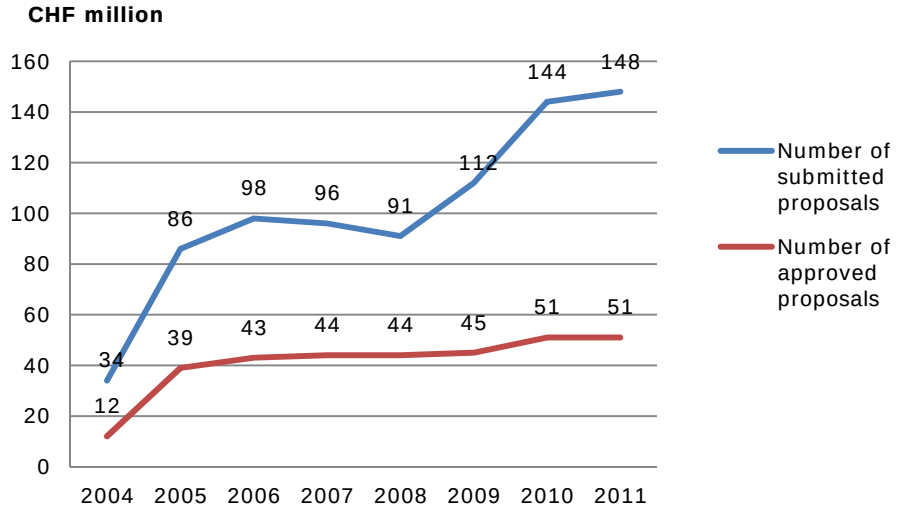

Figure 9: Submitted and approved DORE research projects (2 calls for projects per year except in 2004).

The SNSF conducted the DORE programme to strengthen practice-oriented research at UASs and universities of teacher education (UTEs) in the seven fields[7] across two budgetary periods (2004-2007, 2008-2011). It was designed as a self-contained funding scheme in the Humanities and Social Sciences division with its own budget[8]. The Research Council was extended to include a

[6] Health, social work, art. These training fields, which are regulated at cantonal level, were also incorporated into Switzerland's seven UASs with the amendment of the 2005 Universities of Applied Sciences Act, with the result that they are now under federal responsibility.

[7] Health, social work, education, applied psychology, applied linguistics, music, theatre and art.

[8] 2004-2007 budget: CHF 18 million; 2008-2011 budget: CHF 33 million. These amounts were earmarked in the two corresponding Federal Dispatches on the Promotion of Education, Research and Innovation (SERI) and in the service level agreements with the State Secretartiat for Education and Research.

further three members responsible for the fields of social work, music and health. With five further external experts, these members formed the expert group "DORE Specialised Commission". The CTI had a seat on the Commission in order to guarantee the interface and transfer between the CTI and SNSF. The SNSF Administrative Offices had a scientific and an administrative secretariat, equivalent to a 50% FTE in each case. In addition to practice-oriented research projects, DORE also promoted conferences, publications and courses for young up-and-coming scientists. The terms and conditions governing grants were based on those applicable to general SNSF project funding, with a free choice of research topics.

Field	Number of projects	Requested grants (CHF)	Number of approved projects	Approved grants (CHF)
Art / design	188	39'871'861	65	11'195'610
Music / theatre	76	13'749'046	43	6'511'136
Social work	179	30'558'574	84	12'730'467
Health	199	31'951'274	64	8'338'606
Education	123	23'325'094	56	10'053'802
Applied psychology	27	4'498'490	10	1'025'963
Applied linguistics	17	3'017'879	7	1'193'229
Total	**809**	**146'972'218**	**329**	**51'048'813**

Table 6: Approved DORE research projects (15 calls for proposals, 01.03.2004 - 01.03.2011).

Applications needed to be submitted by 1 March or 1 October. Grants were awarded in accordance with the principle of competition. In order to take account of the particular situations at the UASs and UTEs, the applicants were, in contrast to project funding, able to apply for their own salary, up to a maximum of 20% FTE. Grants were dependent on a potential user (partner from industry) supporting the project, generally by providing funding that amounted to at least 30% of the amount being requested from the SNSF. The evaluation procedure was the same as in project funding.

The key elements of the evaluation, in accordance with general project funding, were scientific quality, originality and project methodology, as well as the qualifications of the applicants. Additionally, the interest on the part of the partners from industry, and thus the broader impact of the project, were also assessed.

Between 2004 and 2011, some 800 research project applications were submitted by researchers from UASs and UTEs, with funding requests totalling CHF 147 million. Around 330 research projects were financed to the tune of CHF 51 million in total. In addition to the funding allocated by the SNSF, approximately CHF 17 million was invested in DORE projects by partners from the practical realm.

The programme was evaluated in 2006 in the form of an internal audit and broadly based survey conducted among current and potential applicants. The survey revealed[9] that DORE, even after the first few years, was already well known among the target groups and had become an important source of third-party funding for the UASs and UTEs. The researchers attested to the fact that DORE enabled projects of a high scientific standard to be conducted, increasing research quality at their institutions of higher education. DORE not only funded practice-oriented research at these institutions but also encouraged it. Numerous centres of competence were set up and expanded at the institutions of higher education during this time. A further positive effect of DORE was the support given to the UASs and UTEs in terms of fostering the next generation of scientists. Research positions for scientific staff were created or co-financed within the scope of project funding. Some 85% of the project funding allocated by the SNSF was related to personnel costs.

[9] Activity Report 2004-2006 of the DORE Specialised Commission, SNSF, December 2006.

Universities of Applied Sciences (UAS) Universities of Teacher Education (UTE)	Number of projects	Percentage
BFH Bern University of Applied Sciences	62	8%
FHNW University of Applied Sciences and Arts Northwestern Switzerland *	127	15.5%
FHO Fachhochschule Ostschweiz	8	1%
HES-SO University of Applied Sciences and Arts Western Switzerland	272	33.5%
HSLU Lucerne University of Applied Sciences and Arts	37	4.5%
Kalaidos University of Applied Sciences Switzerland	7	1%
SUPSI University of Applied Sciences and Arts of Southern Switzerland **	41	5%
ZFH Zürcher Fachhochschule *	178	22%
UTE Universities of teacher education ***	77	9.5%
Total	**809**	**100%**

* UTEs included
** included since 2009: Alta Scuola Pédagogica and Fernfachhochschule Schweiz
*** UTEs include SHLR (Schweiz. Hochschule für Logopädie Rorschach) but exclude the UTEs of ZFH and FHNW and, since 2009, of SUPSI

Table 7: Submitted DORE research projects (15 calls for proposals, 01.03.2004 - 01.03.2011).

DORE ceased to exist as a funding scheme in its own right in 2011, by agreement with the representatives of the disciplinary societies (Fachgesellschaften) and the KFH (Conference of Universities of Applied Sciences). With effect from autumn 2011, the SNSF introduced the category of "use-inspired basic research" into its project funding. This means that a funding category for use-oriented research is now available to the researchers at UASs and UTEs as well as universities. However, the number of applications from UASs and UTEs has not increased significantly in this category, and their success rates are not yet at the same level as that of the other higher education institutions. The SNSF is analysing its experience with regard to this funding category on an ongoing basis.

4.5.2. Initiatives in biology and medicine

A workshop organised by the SNSF in 2001 on the state of clinical research in Switzerland, attended by a diverse range of stakeholders, came to the conclusion that Swiss research in this area often failed to meet international standards with regard to research quality and the quality of patient data. Following an application from the SNSF in its multi-year planning and based on recommendations from the Swiss Science and Technology Council (SSTC), provision was therefore made for the first time in the ERI Dispatch 2004-2007 for a separate budget to strengthen clinical research. From the funding allocated to it, the SNSF earmarked a budget of CHF 43.5 million for patient-oriented clinical research, set up a specialised commission for the definition of future initiatives and calls for proposals and consequently directed the funding in the first instance to the support of publicly announced and competitively evaluated cohort studies (see Section 5).

The further expansion of patient-oriented clinical research and the long-term improvement of the basic parameters for the implementation of clinical studies were also incorporated into the SNSF's multi-year planning and the ERI Dispatch 2008-2011. This meant that funding for scientifically successful cohort studies could be continued and a second call for proposals for further cohorts could be launched. Additionally, following consultation with international experts, the Federal Office of Public Health (FOPH) and the State Secretariat for Education, Research and Innovation (SERI), a concept was developed to establish and fund **Clinical Trial Units** (CTUs), operating as non-pathology-specific, multidisciplinary centres of excellence for clinical research at university hospitals and cantonal hospitals. Two competitive calls for proposals were launched in 2007 and 2008 for funding for the CTUs. The funding was designed as start-up funding with a maximum

duration of five years, with decreasing levels of support during the final two years. Following the two consecutive calls for proposals, all five university hospitals and St. Gallen cantonal hospital received three years of start-up financing and, on the basis of a further interim evaluation, end-of-project funding for the final two years. One of the main focuses of the CTU concept was the national coordination of the individual CTUs through an umbrella organisation, the National Collaborative Center (NCC), which subsequently became the **Swiss Clinical Trial Organisation** (SCTO). The SCTO (see Section 5) is organised as an association, backed by the university hospitals, the Collège des Doyens and the Swiss Academy of Medical Sciences, and receives infrastructure grants from the SNSF in the context of a service level agreement. Over the funding period 2008 to 2011, the SNSF allocated approximately CHF 58 million to these initiatives.

The **Special Programme University Medicine** (SPUM) promotes young clinical researchers in translational, multi-centric and multidisciplinary research projects in the field of clinical neurosciences and clinical heart and circulation research. The ERI dispatch 2008-2011 assigned the SNSF the task of "lending impetus to specific selected areas" of clinical research with a maximum budget of CHF 30 million, thereby "serving the interuniversity allocation of responsibilities and set-up of areas of focus, resulting in an improved structure, at the universities and university hospitals." In consultation with the rectors and with international experts, and given the small budget, two main focuses were identified for this short-term initiative – clinical neurosciences and clinical heart and circulation research; both served to strengthen translational research and young clinical researchers. Given the short duration of the mandate and based on an interim evaluation, the running time of some very successful SPUM projects was extended by a further three years. The continuation of this programme within this narrow subject area is not planned.

Separate rules on calls for proposals and assessment were prepared for all calls for proposals relating to patient-oriented clinical research. Because the broad national anchoring of the cohorts, CTUs and SPUM projects would have made it difficult to find impartial Swiss experts, these consortium projects were evaluated by international panels of experts. Depending on the overall duration of the support, all of the funded initiatives were subject to interim evaluations after two or three years.

For the purposes of optimising funding of biomedical research, the SNSF carried out two national workshops with international involvement in 2009, including representatives from the European Clinical Research Infrastructure Network (ECRIN) and the Biobanking and Biomolecular Resources Research Infrastructure (BBMRI), as a foresight activity. The findings from these workshops were summarised in a concept paper, the recommendations of which were also geared around the "EMRC White Paper: Present Status and Future Strategy for Medical Research in Europe" prepared by the European Science Foundation (ESF), thus guaranteeing the international compatibility of the SNSF initiatives. The main points of this concept, which were incorporated into the multi-year plan for 2012-2016, were: greater support for translational medicine, funding of longitudinal studies (cohorts) and their expansion to non-human populations, the continued support of the SCTO, the creation of a coordination platform for human and non-human biobanks (Swiss Biobanking Platform (SBP)), data-linkage funds for biobanks, the co-financing of protected time for young clinicians, the payment of CTU service costs through project grants, and the funding of investigator-driven clinical research (IDCR).

All initiatives that were not handled directly via project funding, but required a separate call for proposals and budget, were included in the 2013-2016 Dispatch. However, given that the budget is not sufficient for all initiatives, the SNSF has been given greater flexibility with regard to implementation through the SERI/SNSF service level agreement. The call for proposals for longitudinal studies in the human sector was launched in early 2013, with the call for the non-human sector

postponed for the time being. The Swiss Biobanking Platform (SBP) call for proposals was also issued in 2013 (see Section 5). Both evaluation processes will have been concluded by the end of 2013. Next on the agenda, in 2014, are the calls for proposals for data-linkage funds for biobanks and for IDCR projects as well as the establishment of supplementary grants for protected time for clinicians and for CTU service costs.

4.5.3. Long-term applications in the natural sciences

The turnover of interesting issues in many experimental research fields is in the region of ten years (e.g. in condensed matter physics, physical chemistry), as the experiments depend on the development of complex measuring instruments. The expensive nature of experimental laboratory equipment supports the trend towards continuity and research projects designed with longer project durations. Many collaboration projects involving international large-scale apparatus also need the parties involved to commit to the project for several years at a time. Division II has handled funding for this type of research project in the context of project funding for years now. The SNSF does not enter into multi-year commitments but the mutual understanding of the partners (SNSF/PI) is clearly one of "best effort-commitment". The question of whether such projects should be segregated and given their own funding scheme and own budget is one that has been discussed periodically over the past thirty years. Increasingly, however, the associated disadvantages are viewed as outweighing any superficial benefits of a separate evaluation: competition and comparison with smaller-scale research projects should not be prevented, but the long-term projects should be classed differently in financial terms.

Formally, only projects for which there is a signed Memorandum of Understanding (MoU) are recorded in the database as "long-term projects".

Decision year	Share of long-term projects	"Normal" projects
2009	12.8 %	87.2 %
2010	11.2 %	88.8 %
2011	7.3 %	92.7 %
2012	8.4 %	91.6 %

Table 8: Summary figures by year.

Long-term projects without a formal MoU relate in particular to the areas of astronomy, astrophysics, climate research (ice drilling in the Antarctic), experimental chemistry and experimental physics. All of these research projects are closely interwoven internationally and have a proven track record as cutting-edge research at a global level. In the field of astronomy, for example, tough international competition applies to ESA calls, NASA calls, Chinese and Japanese calls. Generally, measurement times for telescopes are awarded through hard-fought competition. In the area of physics, the labels "CERN approved" and "CERN recognized" are a reflection of international top quality and priorities. All large-scale facilities are the subject of intense competition for access: Swiss Lightsource (SLS), all facilities in the USA, and in France (Grenoble).

4.5.4. Long-term applications in the humanities

The long-term projects in the humanities have generally been initiated by individual researchers and/or research groups.

The SNSF's Humanities and Social Sciences division has been handling the long-term projects within the context of project funding. At the time of writing, some 14 publishing projects, 5 collections of legal sources, 4 archaeological excavations and also 2 catalogues, 2 name books and a dictionary are being funded. Over the past four years, two to three projects on average have come to an end or been discontinued per year. As a general rule the projects are evaluated by the Research Council every three years.

The current project durations range from 15 years to a time frame of several decades. With regard to the 30 long-term projects running at the time of writing, the (not always continuous) funding has been provided since the 1970s in the case of 12 projects, since the 1980s in the case of 4 projects and since the 1990s for 6 projects. Eight projects were launched during the first decade of the 21st century.

Decision year	Share of long-term projects	"Normal" projects	Infrastructure grants in CHF
2009	8.43 %	91.57 %	10'698'544
2010	8.87 %	91.13 %	1'334'246
2011	8.04 %	91.96 %	12'545'159
2012	6.87 %	93.13 %	910'005

Table 9: Summary figures by year.

Table 9 shows that approximately 8 percent of Division I's project budget is allocated to long-term projects in the field of the humanities. Within the infrastructure budget (own SNSF budget) further funding is available, e.g. for the Répértoire internationale des sources musicales.

By 2013 the SNSF had provided the 30 projects with total funding in the region of CHF 110 million. Many projects receive co-funding from the cantons, foundations, institutions of higher education etc. The 30 projects include twelve historical/critical comprehensive editions of significant authors, namely Robert Walser, Conrad Ferdinand Meyer, Jeremias Gotthelf, Thomas Mann, Johann Heinrich Pestalozzi, Karl Barth, Heinrich Bullinger, Théodore de Bèze, Johann Caspar Lavater, Friedrich Nietzsche, Jacob Burckhardt, Karl Leonhard Reinhold, which can serve as a model internationally. Additionally, collections of source material, books of records, dictionaries and name books, the large-scale project being carried out by farmhouse researchers in Switzerland and the outline of the history of philosophy (Ueberweg), as well as archaeological digs, are all receiving funding.

4.5.5. Interdisciplinary research funding Background

Until 2006, interdisciplinary grant proposals were treated within or between divisions of the National Research Council (RC). Divisions are constrained to certain fields of research. Statistical analysis revealed considerably lower success rates of interdisciplinary proposals compared to disciplinary ones. The SNSF attributed this situation to inadequate evaluation of interdisciplinary proposals by the disciplinarily organised divisions of the Research Council.

As a consequence, the SNSF presiding board mandated a multidisciplinary expert group, which came up with the proposal to put into action a specific committee for evaluating proposals declared as interdisciplinary by the applicants. In 2006, the SNSF created the Commission for Interdisciplinarity (KID), composed of members of all the divisions of the RC. After a pilot phase of two years, KID continued its work as the Specialised Committee Interdisciplinary Research (FA-ID). Since 2012, the committee has been extended. At the time of writing, it is composed of 2 representatives of divisions I to IV of the Research Council and 5 external members, covering a large spectrum of scientific competences.

Submission year	Number of proposals	Requested budget	Allocated budget
2006	18	5'765'493	2'093'358
2007	56	24'534'456	7'695'844
2008	57	25'973'297	10'542'995
2009	64	30'228'959	9'058'524
2010	73	35'269'172	10'859'773
2011	96	37'619'151	12'637'388
2012	100	44'518'054	15'547'645
Total	**464**	**203'908'582**	**68'435'527**

Table 10: Summary figures by year.

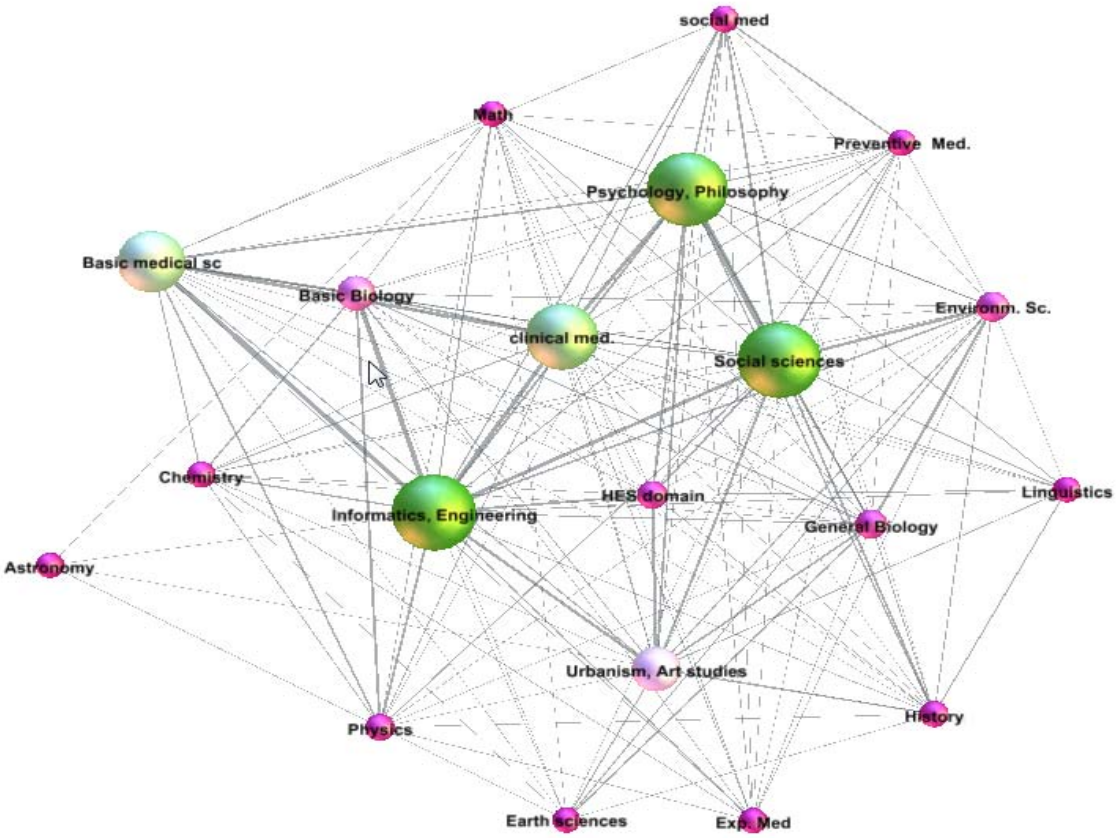

Figure 10: Network of disciplines represented in all interdisciplinary proposals. Nodes correspond to group of disciplines as defined by the SNSF discipline list. Node size and color represent the betweenness[11] centrality of the discipline. The darkness of a link represents its weight.

Proposals

The yearly demand for funding grew steadily from 2006 to reach a total of 100 proposals in 2012 for a requested budget of CHF 44.5 million. In the same year, the total available budget amounted to CHF 15.6 million to fund approximately 35% of the total demand.

[10] The betweenness centrality is equal to the number of shortest paths from all vertices to all others that pass through that node. The link's weight represents the number of times two disciplines are present in a common proposal.

The committee evaluates proposals submitted from a wide spectrum of research domains, from humanities and social sciences (domain 1), mathematics, natural and engineering sciences (domain 2) and life sciences (domain 3). Even though the disciplinary composition of proposals does not show any particular pattern, we observe a strong focus in research involving psychology, clinical research, informatics (included in the node engineering in the graph above) and social sciences.

Applicants

The 464 proposals were submitted by 925 applicants or co-applicants. These researchers can be grouped in two different categories: those who also submitted proposals in Divisions I to III and those who never did. The first group is composed of 690 researchers (75%). Our database does not permit a detailed analysis of their affiliation, age and area of specialisation. Most of them were successful in securing funding at least once for grants evaluated in a disciplinary fashion. Only 23% of those working in the humanities and social sciences never secured funds in Division I. This share is even smaller for usual clients of Division II (14%) and Division III (18%).

The second group is composed of 235 researchers. Their last known affiliations are mostly cantonal universities (45%), followed by ETH and UASs (20% each). The remaining applicants were working in other eligible institutions, such as cantonal hospitals.

These figures show that the possibility to submit interdisciplinary projects was particularly appreciated by researchers working in institutions other than cantonal universities or Federal institutes of technology. Indeed, 13% of main PIs submitting an interdisciplinary grant application are working in UASs or other institutions. This is twice as many as in the disciplinary divisions (8%). More importantly, the introduction of this programme enabled a sensitive number of researchers from these institutions to submit proposals to the SNF: 35% of IDS applicants unknown to Divisions I-III were working in institutions other than universities or ETHs.

4.6. Relation of SNSF responsive-mode funding to thematic programmes

4.6.1. General questions

The current SNSF funding rules set no limits for researchers. While project funding and Sinergia are open to researchers in all disciplines, thematic programmes such as SystemsX, Nano-Tera or National Research Programmes (NRPs) present additional opportunities for funding in certain domains. Seeking to invest funds for research effectively, the SNSF must answer a number of important questions: do thematic programmes and large initiatives correspond to new ideas and methods in research which the SNSF has failed to cover by means of the responsive-mode schemes? Do the two types of schemes attract different research communities or the same researchers? Are the thematic programmes preferentially used by researchers who are not successful in the responsive-mode schemes?

In order to understand potential differences between researchers submitting proposals in project funding and in thematic calls, we considered two groups of applicants: those who only applied for funds in NRPs or large initiatives over the last 5 years and those who also applied for funding in SNSF project funding.

Eligibility might differ between external initiatives, NRPs and project funding. We therefore excluded from our analysis researchers who do obviously not qualify for project funding at the SNSF (Ambizione fellows, researchers working abroad or in a commercial entity).

The results are summarised in the table below. The first column displays the number of researchers who submitted proposals for several initiatives. The second column presents the share of those

researchers who never submitted proposals in the normal SNSF scheme even though formally eligible. The last column shows the success rate and total allocated funding in the Divisions I-III of investigators applying to both funding sources.

		PI never in project funding			PI in project funding	
	Total PIs	Number of projects	Number of eligible projects	Proportion	Success rate	Funded amount 2008-2012
SystemsX.ch	450	48	22	5%	65%	CHF 299 m[11]
Nano-Tera.ch	421	102	82	19%	61%	CHF 171.6 m[12]
NRP 60: Gender Equality	158	68	52	33%	40%	CHF 18.3 m
NRP 61: Sustainable Water Management	277	129	100	36%	53%	CHF 48.1 m
NRP 62: Smart Materials	120	25	20	17%	62%	CHF 50.1 m
NRP 63: Stem Cells and Regenerative Medicine	92	13	7	8%	48%	CHF 35.1 m
NRP 64: Opportunities and Risks of Nano-materials	120	22	17	14%	67%	CHF 44.5 m
NRP 65: New Urban Quality	125	64	42	34%	47%	CHF 18.1 m
NRP 66: Resource Wood	111	50	42	38%	57%	CHF 21.6 m
NRP 67: End of Life	218	77	67	31%	36%	CHF 19.3 m
NRP 68: Soil as a Resource	137	49	41	30%	47%	CHF 25.3 m
NRP 69: Healthy Nutrition and Sustainable Food Production	135	58	47	35%	44%	CHF 19.3 m

Table 11: Summary of projects' eligibility.

4.6.2. SystemsX.ch

SystemsX.ch is based on a "pilot project" operated from 2004 to 2007 by the Swiss Federal Institute of Technology Zurich (ETHZ), the University of Basel (UniBS) and the University of Zurich (UniZH). In 2006, these three institutions founded an ordinary partnership according to Swiss law with the aim of launching a national initiative to fund system biology, based on a positive international review of the pilot project. This idea met with a good response from the then State Secretary for Education and Research Charles Kleiber. The project was subsequently submitted to the Swiss parliament under the name "SystemsX.ch" as part of the ERI Dispatch 2008-2011 (budget of CHF 100 million). However, its approval was subject to the condition that an independent entity, in this case the SNSF, guarantee quality assurance. In December 2006, the SER commissioned the Swiss National Science Foundation with the task of producing a brief report. The SNSF was required to carry out an overall assessment of the project as a whole while also proposing potential evaluation mechanisms. The business plan for SystemsX.ch and the international review of the pilot project were submitted. The working group within the SNSF, composed of representatives from Divisions II, III and IV, presented its report to the Presiding Board of the Research Council in March 2007 for attention of the SER.

[11] Equivalent to an average spending level of about CHF 150'000 per researcher.
[12] Equivalent to an average spending level of about CHF 110'000 per researcher.

By mid-2007 the Presiding Board had adopted the application regulations and selected the internationally composed panel, including representatives of Divisions II, III and IV. Responsibility for the secretariat was assigned to Division IV. The first call for proposals was launched by SystemsX.ch in August 2007. The panel met for the first time in February 2008, with the selected projects beginning their research work by May 2008.

Among the 450 researchers who submitted an RTD or iPhD proposal, only 48 never submitted any proposals in the SNSF's project funding. Among them, a total of 26 are not eligible because they left academia, are Ambizione fellows, work abroad or in a commercial entity. In total, only 5% of all researchers looking for funding in the area of systems biology never submitted any proposals in the SNSF's project funding. Members of this group are all men of between 38 and 41 years of age. Half of them possess a professor title. They are mainly affiliated to institutions based in Basel or Zurich[13].

All other researchers in this domain also submitted proposals in the SNSF's project funding. They mostly submit proposals in disciplines of basic biology and basic medical sciences, with an average success rate of 65%, systematically above the average success rate of applicants in the same scientific domain.

Discipline	301	303	307	205	203	304	302	308	204	207	201	Total
No. of projects	729	269	95	94	72	56	32	30	19	12	12	**1420**
Success rate	69%	58%	53%	69%	60%	61%	78%	73%	68%	67%	42%	**65%**
SNSF avg. success rate	63%	54%	36%	58%	74%	52%	53%	34%	78%	64%	80%	

Table 12: Success rates by discipline (disciplines are listed in Table 2).

All SystemsX.ch applicants already funded by the SNSF received approximately CHF 300 million through project funding during the previous 5 years. This corresponds to a spending level of CHF 150'000 per researcher. SystemsX.ch customers are therefore comparatively well-funded researchers. They are probably attracted to SystemsX.ch by the RTD programme through which large consortia can be funded – as opposed to smaller scale individual funding at the SNSF.

Researchers adapt their fundraising strategy to the existing landscape of funding schemes. The main programme of SystemsX.ch (RTD) has some similarity with Sinergia. In fact, 15 consortia resubmitted 15 rejected RTD proposals in one of the subsequent Sinergia calls with exactly the same network – or a substantial subset. Eight of these consortia were funded by Sinergia.

4.6.3. Nano-Tera.ch

Nano-Tera was designed with a view to providing major funding for engineering sciences in Switzerland. The Swiss federal institutes of technology had repeatedly criticised the SNSF for having an evaluation system that failed to do justice to the field of engineering, as evidenced by the low success rate for applications in this area. Given, however, that engineering sciences fare less well than basic sciences in the success statistics at European level too, the reasons for this phenomenon can be assumed to have deeper roots.

For its part, the EPFL devised an engineering programme with a structure similar to that of the SystemsX initiative. The programme was expedited and, together with the SystemsX project, submitted to the parliament as part of the ERI Dispatch 2008-2011 under the name "Nano-Tera.ch"

[13] This fact must however be contextualised with the strong focus of the initiative in these two institutions.

(budget of CHF 100 million). As with SystemsX.ch, the project was approved subject to the condition that the SNSF guarantee scientific quality assurance.

During an initial presentation of the proposal to SNSF representatives in May 2007, the programme only existed in a very basic form, with the result that the SNSF only agreed in principle to assume the quality assurance role. Due to a delay in the fine tuning of what was a very broad programme outline, it was not possible for the proposal to be evaluated in accordance with the procedure for NRPs. In order to avoid any further delays, the SNSF, following correspondence with the state secretary in January 2008, declared its willingness to carry out the evaluation, limiting it to the individual projects within the call launched in February 2008.

The Nano-Tera programme was specifically geared towards quick implementation, with the research groups being required to create demonstrators as an absolute prerequisite. The SNSF panel was only composed once the entries in response to the first call were known. The international panel met for the first time in November 2008 but, in light of the complex negotiations for third-party funding, the first projects did not get off the ground until the period from March to July 2009.

About 20% of all researchers who applied for funding to the Nano-Tera.ch initiative never applied in SNSF project funding even though they would be formally eligible. These investigators are mostly established researchers with an average age of 50 years. The majority of them do not possess a professor title. Their institutional affiliation is quite diverse. Yet, 45% of them either work at EPFL or CSEM[14]. As research in Nano-Tera is in large parts use-inspired, it may well be that these researchers unbeknown to the SNSF do not feel attracted by the conventional schemes.

All other putative Nano-Tera.ch investigators submitted proposals to the SNSF's project funding. Their success rate amounts to an average of 61% over the five-year period. The vast majority of these proposals (80%) are evaluated in Division II and are tagged by the discipline 20500 (Engineering). There is no particular difference in the success of these researchers at the SNSF since their success rate is very similar to the average success rate in this domain (58%).

As for the SystemsX.ch initiative, seven research networks initially rejected in the Nano-Tera.ch evaluation were re-submitted to the Sinergia program in one of the following calls by the same network – or a substantial subset – of applicants. Six of these consortia were funded by Sinergia.

4.6.4. National Research Programmes

The situation for National Research Programmes (NRPs) is very diverse. The discrepancy between its clientele and that of SNSF project funding depends strongly on the call's subjects. We considered NRPs set up between 2008 and 2012.

The proportion of investigators who apply for funding only in the SNSF thematic calls ranges from 8% in Regenerative Medicine to 38% for Resource Wood. The data presents no particular correlation between the share of investigators raising funds only at thematic calls and the success rate of those who also submit proposals in project funding.

The success rate in SNSF project funding of investigators who also submit proposals in NRP calls also differs between several calls. For most calls, NRP applicants have similar success rates when submitting a proposal to project funding as the SNSF average. This is the case for instance in NRP 61, NRP 62, NRP 64, NRP 65, NRP 66, NRP 69.

Differences in success rates exist in other calls at various scale. They might not be significant (NRP 68) or depend on the discipline (NRP 60, NRP 67). However, these figures must be analysed with

[14] This fact must however be contextualised with the strong focus of the initiative in these two institutions.

care as the number of applicants in the different scientific domains is small and the categories to consider might go beyond the disciplines.

As for Nano-Tera.ch, there is some indication of communities in applied or use-inspired researchers who seek funding but never apply to the SNSF responsive-mode schemes.

4.7. Relation of SNSF responsive-mode funding with European funding schemes

The Swiss research landscape is part of the European Research Area (ERA), whose purpose is the integration of the scientific and technological capacities of the EU member states and associated countries. Aims of the ERA are the creation of an internal market for research, the effective coordination of national and European research activities and the development of research funding at European level.

In the context of this report, it seems appropriate to relate project funding and Sinergia only to the responsive-mode funding on the European level, which is done through the schemes of the **European Research Council** (ERC).

SNSF project funding and ERC **Starting Grants** (StG), **Consolidator Grants** (CoG) and **Advanced Grants** (AdG) offer competitive research funding for independent scientists and thus overlap in their target group in Switzerland. The ERC Grants are much larger, though, and can also be used to pay the salary of the principal investigator. These three ERC schemes have considerably lower sucess rates than the Swiss schemes as they reflect competition across a continent and not within a country. Despite the great success of Swiss researchers in the ERC, in absolute numbers the ERC funds only very few researchers in Switzerland. In 2012, only 26 new AdG and 33 new StG started in Switzerland; first results for CoG are being published in December 2013, in parallel to the writing of this report.

The StG and AdG are, and will continue to be funding schemes for a very small elite. SNSF's project funding is the main funding scheme for basic research in Switzerland, providing competitive research funding for excellent scientists. By promoting national competition, SNSF funding not only creates the basis for the success of Swiss researchers at the ERC, but it continues to identify and support researchers who are competitive on the European level. 94% of AdGrantees and 92% of StGrantees in Switzerland (of those who had already worked in Switzerland before they received their ERC grants) had received funding from the SNSF (via project funding or SNSF professorhips). Almost 80% of the Swiss ERC grantees apply for and receive funding also after the start of their ERC grant (mainy through project funding).

SNSF Sinergia and ERC **Synergy Grants** both support small, and often interdisciplinary, networks of advanced researchers which plan to venture into promising new research fields. In contrast to the Pan-European Synergy grants, Sinergia networks are mainly Swiss-based, with the participation of one group outside Switzerland. The ERC Synergy Grants are rather insignificant for the Swiss research system at the moment. There have only been two pilot calls, for the first of which the results are already available. The call had a success rate of 1.6% with only 11 projects - one with Swiss participation - being funded.

The **ERA-Net** and ERA-Net+ schemes have existed for many years and are considered a success. Apparently, ERA-Nets will play a more important role in Horizon 2020, especially in the Societal Challenges Part, but also in other fields. At the time of writing, the SNSF is taking part in about ten ERA-Nets, some of which are thematic, others regional. The decision-making process with regard to participation has not always been transparent, although a decision process was set up.

Like NRPs, **Joint Programming Initiatives** (JPIs) – which formally are not a scheme of FP7 or Horizon 2020, but intergovernmental initiatives – aim at pooling national programmes and thus achieve the critical mass needed to address major societal challenges more effectively. JPIs and NRPs clearly differ in size and structure. Ten JPIs are currently underway; the SNSF, together with the SERI, which has the overall responsibility for the JPIs in Switzerland, had to decide which topics are more suitable for the creation of NRPs and which JPIs it wanted to participate in, or to link new NRPs to existing or planned JPIs. Switzerland is currently a member of five out of the ten existing JPIs; the SNSF is taking part in four of them.

4.8. Summary and conclusions

Funding in the **responsive mode** (project funding and Sinergia) is the backbone of SNSF funding in terms of importance, investment and evaluation work. In the previous sections, analysis of discipline funding, institution funding, grant size, coverage of the scientific community and relation between publication activity and SNSF activity (only for biology and medicine) were presented. The results allow for the following **statements and conclusions**:

The SNSF funds the different disciplines largely as a function of their financial demand and adapts to changing demands quite quickly, probably more flexibly than with thematic programmes and corresponding budgetary envelopes. The 'activity level' of disciplines at the SNSF in terms of numbers of proposals and financial demand is very heterogeneous. The general activity level in all schemes is on the whole increasing. The structure and working capacities of the National Research Council and the Administrative Offices have not developed accordingly. Modifications will be suggested for 2015.

- Most SNSF applicants come from the cantonal universities and the ETH domain. The respective partitioning between research fields corresponds to the activity of the institutions in these domains. Researchers from the UASs and the UTEs use the SNSF only to a very limited extent. The weak coverage may in part be explained by the fact that the major role and tradition of the SNSF is to fund basic research and that evaluation procedures need to be further adapted to use-inspired research. The major reason, however, very likely resides in the design and structure of the UASs / UTEs, which do not facilitate research for non-commercial purposes.
- In terms of grant size, there are strong differences between disciplines which seem to be justified in large parts by the differences in research costs. However, the SNSF has no real indication of needs and research costs as it only contributes to research costs and because researchers have different strategies and co-funding levels concerning their proposals. Limited grant size and lifetime is probably one reason why researchers address multiple proposals to the SNSF.
- Estimating the coverage of university researchers is difficult due to non-matching data from different sources. It seems that coverage is highest in MINT, followed by biology and medicine and very heterogeneous in the humanities and social sciences. As there is no international scientific evidence concerning this parameter, interpretation of this data is difficult.
- In order to learn more about each of the previously mentioned topics, a researchers' survey mandated by the SNSF is being conducted by the Nordic Institute of Studies in Innovation, Research and Education (NIFU) at the time of writing. Based on the results and on its own analysis, the SNSF may modify project funding and Sinergia.

- Project funding and Sinergia and the ERC funding schemes attract the same target group in Switzerland - the most competitive researchers – but have very different purposes. Participation of Swiss-based researchers in ERA nets should be facilitated pro-actively by the SNSF.
- According to the pilot study based on topic modeling, there is some disparity between the publication activity of researchers in biomedical research and the needs for funding as submitted to the SNSF. Even if the tool has several shortcomings and results needs very careful interpretation, it serves very well to document and visualise ongoing research and has numerous additional applications (e.g. search for reviewers and panel members, detection of emerging disciplines, foresight, etc.). The SNSF will thus seek to further develop the tool and include more research fields.

In several cases the SNSF funded certain research fields or research communities in the **pro-active mode**. The **motivations** for doing so can be summarised as follows:

- capacity-building in response to needs expressed by research communities or political stakeholders
- long-term investment as required by the nature of research and its organisation in certain areas, in particular international consortia
- long-term data acquisition as required for further research in certain fields (infrastructure)
- counter-measures to under-funding of certain research fields or communities
- reaching out for new research fields or communities

The following **statements and conclusions** can be made with respect to the current funding policy in the pro-active mode:

- Considerable monitoring/foresight activities are necessary for effective and balanced funding in the pro-active mode that is not subject to lobbying by individual research communities. The SNSF needs to do foresight work more systematically but is limited by the current workforce.
- There is a problem concerning evaluation when long-term strategic investments compete directly with individual short term grants in project funding, a funding scheme designed for the responsive mode. The SNSF can handle pilots for these long-term investments in project funding but must then have a standard process to include them in its multi-year plans. As many of these investments are of national importance, the SNSF also calls upon the responsibility of other Swiss stakeholders, particularly concerning costly domains. In the grey zone between purely responsive mode and strategic investments are long-term commitments (e.g. for experiments or editions).
- Thematic programmes, be they international, SNSF-external or internal initiatives or NRPs, can create added value in terms of new research and new research communities. In some research fields, however, they may rather be an additional funding source for ongoing research and already well-funded communities.
- Funding in the pro-active mode and evaluating SNSF-external initiatives represents an additional workload for the National Research Council, which is already stretched to the limit.

5. Infrastructures: characteristics of current funding

5.1. Overview

The SNSF bases its definition of infrastructure on that used by MERIL (Mapping of the European Research Infrastructure Landscape), a project funded by the ESF (European Science Foundation) with the aim of providing an inventory of European infrastructures http://www.esf.org/activities/science-policy/research-infrastructures/meril-mapping-of-the-european-research-infrastructure-landscape.html

An infrastructure is a facility or a (virtual) platform that provides the research community with research resources and services in their respective specialist field. Infrastructures may be distributed across single or multiple locations or take the form of an "e-infrastructure". They may also form part of large-scale national or international networks and groupings. Research infrastructures should

- offer high-quality services with at least national relevance;
- offer researchers from Switzerland (and other countries) access via transparent processes based on the applicants' scientific track record;
- have a stable and efficient management structure.

Long-term publishing projects in the humanities are included in most international infrastructure definitions. In this report, they are treated in section 4 as they represent long-term investments in specific research domains. The same reasoning applies to the cohort studies in biology and medicine.

Between 2008 and 2012, the SNSF invested between CHF 42 and 50 million per year for new and existing infrastructures. Approximately one fourth to one third of this investment was used to purchase new instruments for research in the MINT and life sciences domains (R'Equip) and cannot thus be considered as infrastructure in the strict sense. The remaining part (CHF 29-37 million per year) represents long-term investments. Infrastructures funded by the SNSF range from large-scale equipment and its operation in the natural and engineering sciences via biobanks to surveys and cohorts in the social sciences.

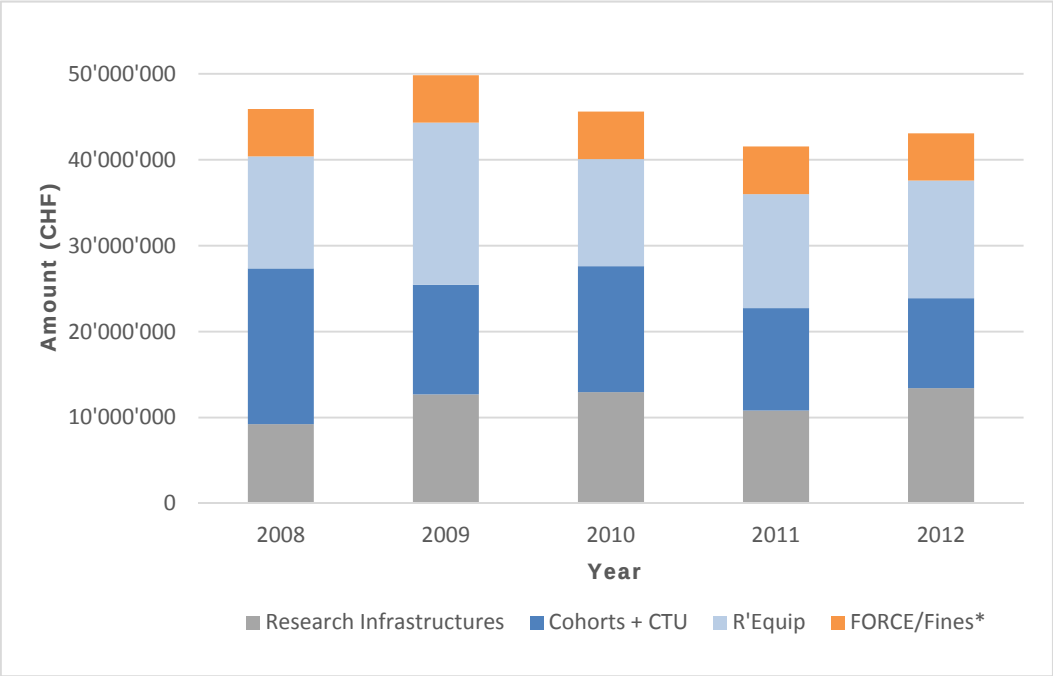

Figure 11: Funding for infrastructures, excluding long-term projects within project funding in the humanities and social sciences (cf. section 4.5.3 and 4.5.4).

Year	2008	2009	2010	2011	2012	Total
Research Infrastructures	9'218'819	12'687'818	12'955'427	10'814'075	13'409'772	**59'085'911**
Cohorts + CTU	18'127'465	12'762'845	14'658'337	11'912'116	10'483'205	**67'943'968**
R'Equip	13'044'214	18'865'568	12'458'615	13'264'267	13'688'138	**71'320'802**
FORCE/Fines*	5'500'000	5'513'800	5'528'000	5'542'407	5'493'222	**27'577'429**

* *financed separately through a SERI credit*

Table 13: Funding for infrastructures, excluding long-term projects within project funding in the humanities and social sciences (cf. section 4.5.3 and 4.5.4).

5.2. Origin of infrastructures and current funding mode

The origins of the currently funded infrastructures are quite diverse. There are only a few examples of infrastructures (most infrastructures related to FORS) initiated through an SNSF programme (Swiss Priority Programme 'Switzerland – Towards the Future'). Many other infrastructures form part of larger international structures. They have been initiated outside Switzerland (e.g. the International Continental Drilling Program or the European Social Survey), and Swiss researchers would like to participate. In these cases the SNSF pays for the Swiss contribution. Some of these international infrastructures are on the roadmap of the European Strategy Forum of Research Infrastructures (ESFRI). The infrastructures in the fields of biology and medicine (cohorts, clinical trial units) are part of a larger national initiative for capacity-building in clinical research in Switzerland (see section 4). Other infrastructures were initiated by groups of researchers in Switzerland and are entirely Swiss-based, although they attract and enable international research, e.g. the High Altitude Research Stations at Jungfraujoch and Gornergrat or the Centre Européen de Calcul Atomique et Moléculaire.

In line with their diverse origins, the funding mode of infrastructures at the SNSF varies, too. There are neither general funding regulations nor open calls for infrastructure proposals at the SNSF. For the infrastructures in the fields of biology and medicine, the SNSF received separate budgetary envelopes in the three last ERI dispatches. Calls were launched and infrastructures selected through competitive evaluation procedures. For other infrastructures, the SNSF was mandated by SERI to perform evaluation and lifetime management through a separate budget line, e.g. former FORCE/FINES. In certain cases, SNSF representatives are even part of the scientific committees/steering boards of the infrastructures (e.g. FLARE). Many demands for infrastructure, however, come in as researcher-driven proposals to Divisions I, II and III. They are either financed via the open infrastructure budget of approximately CHF 20 million, which the SNSF earmarks each year, or they are even financed via the budget for project funding (e.g. publishing projects in the humanities).

5.3. Evaluation and eligible costs

Apart from the infrastructures of the domain biology and medicine (see above), new and existing infrastructures are evaluated in Divisions I, II and III. As there are no specific funding regulations, the general funding rules are applied and infrastructures are evaluated every three years. Not many proposals for infrastructures have been turned down in the past. Others have been financially cut or increased. The implicit criteria currently used for evaluating infrastructures are the following:

- need (based on scientific issues, questions and projects)
- quality (of the infrastructure, of the research involved, of the responsible researchers)
- management
- accessibility, availability and (inter)national visibility

When evaluating an existing infrastructure, the scientific activities and output/outcomes of research related to that infrastructure are an additional, very important criterion. Currently eligible costs are the following:

- For structures: salaries of scientific and technical staff, as well as material costs incurred in setting up and launching the infrastructure or during the initiation phase for operating the infrastructure (salaries for doctoral students are excluded).
- For services: salaries of scientific and technical staff, material costs and financial contributions used for coordination and networking with existing or emerging research initiatives, securing data access and data usage rights, and the preparation of data for research purposes.
- For coordination of research areas: workshops, seminars, office costs (personnel, IT, rents).

5.4. Lifetime and co-funding

Within the initiative in biology and medicine, the financial support of the clinical trial units by the SNSF was limited from the outset to three ERI dispatch periods and to a certain budget. Some long-term publication projects in the humanities have planned lifetimes of tens of years and more. For international drilling programmes, ten-year contracts must be signed. In all other cases, infra-

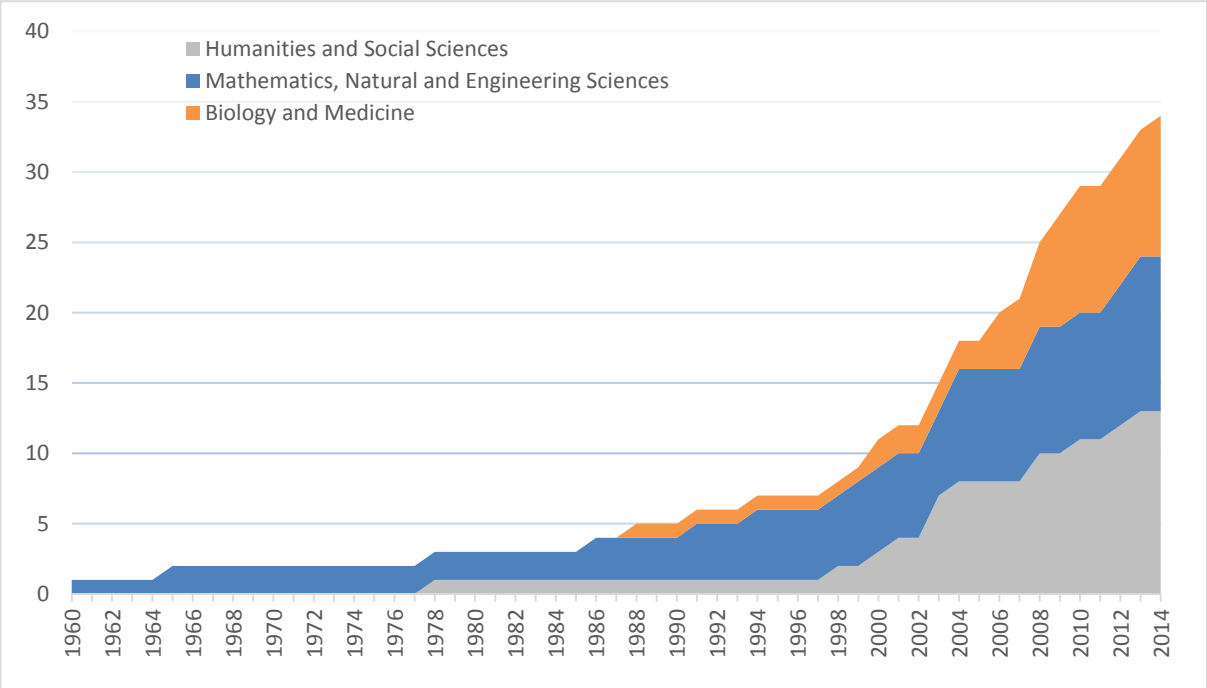

Figure 12: Number of research infrastructures with SNSF participation over the years.

structures have no à priori determined lifetime. Therefore, some infrastructures have been funded by the SNSF for decades. The financial demands of infrastructures vary over time, most of them having increased.

Many infrastructures have secured co-funding, but not all. The SNSF fraction of the total infrastructure costs varies between approximately 10% and 100%. In most cases, SNSF funding makes up an important part of the overall budget of an infrastructure. In many cases, particularly with international contracts, the entire costs of the infrastructure are not precisely known to the SNSF.

5.5. Critical review

Although infrastructures do not make up a significant part of the SNSF budgetary envelope, the SNSF should have a clear role in the Swiss context when it comes to funding infrastructures. The current legal situation with several stakeholders being potentially responsible for infrastructure funding is not easily understandable to researchers. The absence of clear infrastructure funding rules at the SNSF (as a result of the unclear situation) adds to the confusion.

Infrastructures funded by the SNSF have essentially two origins – either exclusively researcher-driven (participation in international infrastructures or creation of new infrastructures) or indirectly researcher-driven and in part politically motivated (e.g. ESFRI roadmap). While the SNSF decides independently concerning the first category, it is often mandated to fund the second category. One single national process and budget for infrastructure funding would be desirable, as well as an efficient coupling to the ESFRI roadmap process.

Infrastructure funding fits the SNSF portfolio and competencies only to a limited degree. The SNSF's major task is funding research on a competitive basis, the only criterion being scientific quality. Although the scientific quality of related research is a threshold criterion for infrastructures, the major decision to be made is of a strategic nature, and competition is often lacking (e.g. telescopes).

In addition, long-term funding is compatible with the SNSF portfolio and mandate only to a limited degree and bears long-term risks for the infrastructures. In the absence of clear perspectives on lifetime and long-term funding, the SNSF must set aside a budget for existing infrastructures which would otherwise be shut down or significantly reduced. Due to generally rising costs and the drive to improve quality, existing infrastructures tend to become more costly over time. The comparatively small infrastructure budget of the SNSF is therefore largely closed to new infrastructures.

The evaluation of infrastructures can be problematic in several respects. First, due to the absence of clear rules there is a lack of explicit criteria and consequently of transparency. Second, the three-year term dictated by the general funding regulations is not appropriate for infrastructures. Third, due to the absence of open or thematic calls in most cases, the needs of scientific communities or parts of them may not be considered by the SNSF in a balanced way.

6. Characteristics of future SNSF funding – suggestions

6.1. Research Fields

The responsive mode should remain the main funding mechanism of the SNSF and project funding the principal funding scheme. As with all its funding schemes, the SNSF strives for excellence in project funding and seeks to foster high-quality research free of any predefined purposes.

Through project funding, the SNSF aims to support the **freedom of research**. Project funding should remain open to researchers from all fields/disciplines. The SNSF should continue to use the scheme mainly to support **fundamental research** for which the demand is high and other funding sources are scarce, as well as for use-inspired and applied research.

To researchers in Switzerland, project funding should offer **equal opportunities for public funding**, independent of their host institution. Its objective is to provide researchers with a certain independence from institutional environments and strategies which vary regionally and may change rapidly.

The results of the current researchers' survey and internal reflections of the NRC will help to improve project funding in terms of the response to researchers' needs as well as effectiveness and efficiency.

Spending a large portion of its budget on research ideas without any topical, strategic or institutional constraints is a feature which clearly distinguishes the SNSF from most other funding agencies worldwide, most likely ensures its effectiveness and may contribute to the country's excellent standing in research.

The SNSF should invest pro-actively only into research domains for which a clear need for a special incentive has been identified. In order to identify such domains, but mostly to better anticipate future trends and developments, the SNSF should **increase its foresight activities** and

improve and expand its monitoring tools. Investments should only be made following active monitoring/foresight, transparent interaction with research communities as opposed to lobbying and quality control through international evaluation.

While project funding may leave some room for pilots, **strategic long-term investments should be integrated into the multi-year planning** and their implementation depend on the budget allocated through the ERI dispatch. An example of a currently launched pilot which may turn into a long-term strategic investment, eventually in cooperation with the CTI, is PrecoR, the SNSF initiative to fund precompetitive research in the engineering sciences. The approach of integrating strategic long-term investments after foresight/pilot activities will be systematically applied for the Multi-Year Programme 2017-2020.

The SNSF should pro-actively invest only when universities or federal departments alone cannot stimulate or organise coordinated action. On the other hand, particularly in the case of international structures or consortia, the participation of researchers from Switzerland or of Switzerland as a country should also be backed politically and supported by SNSF-external funds. In general, the SNSF should be very cautious and constrained with pro-active investments, as it is the role of the universities to set themes in research.

The SNF should not try to integrate very large initiatives such as SystemsX.ch or Nano-Tera into its portfolio. Compared to the total budgetary envelope of the SNSF, these initiatives are much too large and would change the funding priorities drastically. The SNSF even cautions against such initiatives as their size bears various problems of coordination and of conflicts of interests in a small country such as Switzerland. If, however, more of these initiatives should prove necessary, **the SNSF should make sure that it is involved early-on in the set-up process as well as in the evaluation phase** in order to monitor the scientific quality and good governance, and to ensure that large initiatives are open to the entire research community concerned in Switzerland in a fair and transparent way. The SNSF may also recommend the internationalisation of an initiative if appropriate.

Whether the SNSF should offer an additional scheme in the responsive mode for medium-sized consortia remains to be resolved. NCCRs correspond to this size. Calls are open to all research fields and provide a means of obtaining long-term investments for consortia of intermediate size for researcher-driven ideas, but they may not be appropriate for reacting quickly to new research ideas. Sinergia provides funding for small networks, but the spending level of subprojects and the lifetime are identical to those of individual project funding. As the SNSF aims to keep the number of funding instruments as low as possible and will thus not launch an additional scheme, Sinergia and project funding are currently being closely examined in order to improve these points.

6.2. Infrastructures

In accordance with the Research and Innovation Promotion Act (RIPA), the SNSF bears responsibility, subsidiary to the higher education research bodies and the Confederation, for funding infrastructures. This must be compatible with the principles of competitive research funding, as enshrined in the Statutes of the SNSF and in the general Funding Regulations. Taking into consideration these underlying parameters**, infrastructure funding cannot be one of the SNSF's main focuses.**

The SNSF would very much appreciate a **Swiss-wide infrastructure budget and process** in order to better coordinate and prioritise infrastructure needs on the national (and international) level and to attribute clear responsibilities for infrastructure funding to the different ERI stakeholders

(ETH domain, CRUS, Academies, SNSF). The recently launched call for infrastructures, jointly with SERI, should be a first step in this direction. It includes all stakeholders in Switzerland and it streamlines the roadmap process in view of the ERI dispatch 2017-2020 and the next ESFRI roadmap.

A recently consolidated position paper of the National Research Council sets out the nature and funding conditions of infrastructures which the SNSF should have in its portfolio:

- The SNSF should fund **only infrastructures that are required on the basis of specific scientific issues and questions from researchers**. These must have a direct link to research projects and/or promote research capacities in specific scientific areas.
- Infrastructure funding by the SNSF should generally take the form of **multi-year start-up or follow-on financing or of support provided for a limited term**, for a maximum of 10 years. This would require **financial co-responsibility and sponsorship on the part of higher education research institutions or other organisations**.
- The SNSF regards it as the **role of academies, specialist associations and research institutions to enable or facilitate coordination between researchers** in Switzerland and with national and international infrastructures, provided that this relates to the coordination of entire scientific fields. The SNSF currently funds infrastructures for these purposes and would like to transfer them to the academies.

7. Appendix

7.1. Project funding and Sinergia

Data basis

The data in chapters 4.2 to 4.4.2 as well as in this chapter of the Appendix includes project funding and Sinergia, in line with the nomenclature applicable to SNSF annual reports since 2011. Project funding includes interdisciplinary and interdivisionary projects, analysed on the basis of the main discipline indicated by applicants, 'Langzeitprojekte', projects funded within the scope of Eranets or Eurocores or DACH-cooperation as well as DORE projects. It excludes conference grants, summer and graduate schools, intiatives in biology and medicine and infrastructure funding. Since the categorisation of funding schemes for the annual reports changed in 2011, discrepancies are possible for earlier years.

Project funding

Submission year	No. of applications submitted	No. of applications approved	Success rate (no.)	Requested amount	Amount granted	Funding rate (amount)	% SNF funding
2008	1'865	1'227	66%	648'329'118	352'429'992	54%	53%
2009	1'906	1'087	57%	737'097'379	348'890'803	47%	49%
2010	2'276	1'183	52%	851'225'341	358'258'120	42%	49%
2011	2'407	1'229	51%	878'206'311	358'989'141	41%	50%
2012	2'221	1'206	54%	866'866'200	391'404'244	45%	52%
Total	**10'675**	**5'932**	**56%**	**3'981'724'349**	**1'809'972'300**	**45%**	**51%**

Table 14: Project funding.

Sinergia

Submission year	No. of applications submitted	No. of applications approved	Success rate (no.)	Requested amount	Amount granted	Funding rate (amount)	% SNF funding
2008	19	9	47%	30'629'338	12'747'037	42%	2%
2009	88	39	44%	145'714'307	49'329'305	34%	7%
2010	90	40	44%	151'923'678	47'901'289	32%	7%
2011	90	34	38%	146'607'544	49'008'269	33%	7%
2012	91	36	40%	144'468'380	46'233'771	32%	6%
Total	**378**	**158**	**42%**	**619'343'247**	**205'219'671**	**33%**	**6%**

Table 15: Sinergia.

Project funding and Sinergia, Grants by research institution type

Year	Cantonal university		EPFL/ETHZ		ETH-research institutes		Universities of applied sciences and teacher education		Various	
	Amount	*No.*	Amount	*No.*	Amount	*No.*	Amount	*No.*	Amount	*No.*
2008	232'851'467	*769*	99'886'928	*331*	12'548'821	*53*	9'930'132	*50*	9'959'681	*33*
2009	262'358'151	*696*	96'867'801	*285*	13'826'975	*49*	10'942'116	*56*	14'225'065	*40*
2010	263'423'073	*722*	102'393'431	*335*	15'694'709	*66*	10'563'274	*60*	14'084'922	*40*
2011	269'363'063	*750*	92'665'361	*326*	17'440'475	*66*	15'485'359	*76*	13'043'152	*45*
2012	283'439'090	*741*	106'122'275	*340*	16'485'874	*72*	12'415'374	*45*	19'175'402	*44*
Total	**1'311'434'844**	***3'678***	**497'935'796**	***1'617***	**75'996'854**	***306***	**59'336'255**	***287***	**70'488'222**	***202***
Share	**65%**	***60%***	**25%**	***27%***	**4%**	***5%***	**3%**	***5%***	**3%**	***3%***

Table 16: Project funding and Sinergia

Project funding and Sinergia by discipline group

Discipline	Number of proposals	Number of proposals approved	Success rate (number)	Requested amount (CHF)	Amount granted (CHF)	Funding rate (amount)
101	956	426	45%	301'833'324	110'344'246	37%
102	1'304	538	41%	402'057'760	126'006'752	31%
103	315	184	58%	104'400'890	49'498'109	47%
104	641	298	46%	230'176'559	82'908'271	36%
105	357	172	48%	131'516'217	52'891'973	40%
201	323	260	80%	114'354'894	64'387'725	56%
202	96	74	77%	71'980'415	40'357'884	56%
203	571	420	74%	259'130'225	130'865'376	51%
204	674	527	78%	343'858'940	203'668'514	59%
205	1'313	761	58%	461'425'960	177'433'113	38%
207	365	233	64%	129'258'068	58'018'893	45%
208	380	288	76%	124'649'979	65'804'997	53%
301	1'004	634	63%	613'702'798	330'464'885	54%
302	401	214	53%	178'118'664	94'213'203	53%
303	757	405	54%	406'127'804	175'264'210	43%
304	565	293	52%	300'350'389	133'403'045	44%
307	828	297	36%	350'191'367	100'364'333	29%
308	150	51	34%	57'865'182	14'287'487	25%
309	53	15	28%	20'068'161	5'008'955	25%
Total	**11'053**	**6'090**	**55%**	**4'601'067'596**	**2'015'191'971**	**44%**

Table 17: Project funding and Sinergia by discipline group, 2008-2012

Spending level, Projects[15]

Year	Number of proposals	Avg. amount requested (CHF)	Spending level asked (CHF)	Spending level granted (CHF)
2008	1'865	345'358	133'823	112'005
2009	1'906	383'371	144'973	123'471
2010	2'276	370'592	141'464	117'455
2011	2'407	361'772	136'823	113'197
2012	2'221	387'851	143'843	122'766
Total	**10'675**	**370'067**	**140'246**	**117'628**

Table 18: Spending level, 2008-2012, main contributions

Spending level, Projects 2008-2012

Discipline	Number of proposals	Avg. amount requested (CHF)	Spending level asked (CHF)	Spending level granted (CHF)
101	939	287'504	111'561	94'960
102	1'278	276'435	113'317	92'236
103	311	310'081	115'141	94'901
104	618	299'155	127'436	107'557
105	348	336'632	127'429	106'834
201	321	348'272	135'213	100'266
202	91	628'134	280'981	257'202
203	559	431'137	164'898	121'739
204	657	475'111	199'072	159'901
205	1'252	300'126	113'843	84'523
207	349	309'267	119'069	93'784
208	375	302'214	120'017	98'879
301	928	518'565	180'747	156'407
302	386	403'744	138'473	136'884
303	717	454'160	159'245	134'980
304	538	475'471	163'635	138'525
307	809	394'053	144'507	114'976
308	149	382'383	147'517	107'813
309	50	307'033	123'748	104'330
Total	**10'675**	**370'067**	**140'246**	**117'628**

Table 19: Spending level by discipline, main contributions

[15] Project funding defined as in annual reports (inkl. 'Langzeitgesuche')

Sinergia: Spending level (SL) and number of proposals

	SL requested per group (CHF)	Proposals	SL granted by subprojects (CHF)
Humanities	**132'528**	**80**	**108'554**
Philosophy and Education sciences	140'653	17	118'399
Social sciences, Economics	127'762	25	107'873
History	117'013	4	132'693
Archaeology, Ethnology, Visual arts	143'157	21	88'527
Linguistics and literature	108'114	11	115'949
UAS domain	176'760	2	
MINT	**128'192**	**105**	**99'704**
Mathematics	95'765	2	93'446
Astronomy	228'113	5	126'624
Chemistry	114'509	11	88'621
Physics	156'690	14	137'287
Engineering (informatics)	118'202	55	83'954
Environmental sciences	122'889	15	100'121
Earth sciences	110'112	3	84'755
Life sciences	**153'189**	**170**	**127'132**
Basic Biology	148'813	69	125'760
General Biology	132'355	14	116'648
Basic medical sciences	171'253	40	127'128
Experimental medicine	160'588	24	143'707
Clinical medicine	145'300	19	118'519
Preventive medicine	98'282	1	
Social medicine	119'304	3	66'667
Total	**141'140**	**355**	**114'535**

Table 20: Sinergia - Spending level and number of proposals; analysis at group-level may lead to differences from analysis at project-level as published in annual report.

No. of proposals and success rate in project funding by NRP's investigators

	Success rate	Proposals	Avg. Success rate SNSF
NRP 60: Gender Equality	**40%**	**182**	
101	26%	35	45%
102	40%	101	41%
103	50%	16	58%
104	60%	10	46%
105	63%	8	48%
106	42%	12	45%
NRP 61: Sustainable Water Management	**52%**	**387**	
102	28%	53	41%
106	0%	2	
205	48%	33	58%
207	57%	264	64%
208	63%	8	76%
302	52%	27	53%
NRP 62: Smart Materials	**60%**	**347**	

203	72%	71	74%
204	50%	6	78%
205	58%	239	58%
301	56%	9	63%
303	63%	19	54%
304	0%	2	52%
307	0%	1	36%
NRP 63: Stem Cells and Regenerative Medicine	**45%**	**199**	
101	40%	15	45%
102	20%	10	41%
301	47%	91	63%
303	49%	45	54%
304	58%	12	52%
307	43%	7	36%
308	37%	19	34%
NRP 64: Opportunities and Risks of Nanomaterials	**64%**	**282**	
102	0%	2	
203	74%	34	74%
205	55%	58	58%
207	67%	82	64%
301	79%	14	63%
302	50%	20	53%
303	81%	26	54%
304	55%	31	52%
307	60%	15	36%
NRP 65: New Urban Quality	**48%**	**157**	
102	58%	12	41%
104	45%	126	46%
205	69%	13	48%
208	50%	6	
NRP 66: Resource Wood	**58%**	**166**	
102	0%	1	41%
104	0%	1	46%
201	0%	2	80%
203	62%	21	74%
205	60%	117	58%
207	40%	5	64%
301	100%	1	63%
302	56%	18	53%
NRP 67: End of life	**36%**	**241**	
101	35%	43	45%
102	30%	47	41%
104	67%	6	46%
106	17%	6	
303	57%	7	54%
307	36%	81	36%
308	33%	6	34%

309	38%	45	28%
NRP 68: Soil as a Resource	**46%**	**242**	
102	35%	68	41%
205	50%	6	58%
207	52%	132	64%
208	100%	1	76%
301	100%	1	63%
302	38%	34	53%
NRP 69: Healthy Nutrition and Sustainable Food production	**44%**	**183**	
101	25%	4	45%
102	43%	49	41%
104	50%	2	46%
105	0%	1	48%
106	38%	13	
203	57%	7	74%
205	53%	15	58%
207	42%	19	64%
302	45%	11	53%
303	33%	3	54%
304	52%	21	52%
307	59%	17	36%
308	33%	3	34%
309	22%	18	28%

Table 21: Success of NRP applicants when submitting proposals in project funding.

7.2. Estimation of Coverage

Scope:
The analysis of coverage puts into relation, by discipline, the number of researchers having submitted SNF proposals in 2011, or benefitting from an ongoing grant in 2011, with the number of researchers active at the universities, ETHZ and EPFL in 2011.

The universities of applied sciences and of teacher education, private institutions as well as those falling under the institutional category UI/IU of the Federal Statistical Office (FSO), which includes the Institut universitaire Kurt Bösch and Universitäre Fernstudien, were not considered.

Sources
Sources for the analysis are SNSF proposal and grant data as well as the FSO data on personnel at the Universities (including the ETHZ and EPFL), provided to the SNSF on request at the level of the individual universities and personnel categories. Interviews with competent staff at the FSO and the research institutions took place and data at a departmental/institutional level provided by certain universities helped to refine the match between SNSF and FSO disciplines.

Discipline matching
New discipline groups were devised to match the FSO's and SNSF's categorisations. In some cases the matching was refined at an institutional level, for example for the FSO discipline Sport, which covers sport medicine in Basel, sport pedagogy and psychology in Berne and falls under the field of biology at the ETHZ. Certain researcher groups included by the FSO in the exact and natural

sciences could, after discussion with the research institutions, be reallocated to economics (for example finance at EPFL), geography or architecture. Other groups of researchers included in the exact and natural sciences by the FSO could not be matched to any SNSF discipline, since they overlapped Division II and III. Consequently, the number of researchers active at the universities in the disciplines of SNF division II is lower than it appears at first sight.

The somewhat heterogeneous level of aggregation of the new discipline groups is the result of the varying alignment between SNSF and FSO categories and attempts to maximise the level of detail while reducing biases. Overall, 6% of researchers could not be matched precisely to an SNSF discipline and were excluded from the analysis at the level of the disciplines, resulting in an overestimation of coverage. At the next level of aggregation (social sciences, humanities, mathematics), the proportion of non-matches decreases to 4%. At the level of the division, the proportion of non-matches is at only 3%, with greater overlap between between division II and III, so that the overestimation of results is more pronounced for these divisions.

The discipline categories applied by the FSO for researcher data reflect institutional affiliation rather than research portfolios, which is problematic for researchers with multidisciplinary or interdisciplinary research interests, such as biomedicine or environmental research. Errors are reduced at a higher level of aggregation, even if there are grey zones at the level of the divisions, for example between biology (Division III) and environmental sciences (Division II), or between human geography (Division I) and earth sciences (Division II).

Definition of potential applicants for SNSF funding
As an approximation of the circle of potential applicants for SNSF project funding at the universities, the analysis draws on the FSO's personnel categories I-VII. The universities' personnel categories, which serve as a basis for the FSO's categories, are however broad and heterogeneous, so that the chosen inclusion criteria may not be the best approximation for all institutions. Although the categories I-VII should, according to the research institutions, include predominantly research staff, administrative and research positions may not always be completely dissociated, which could result in an underestimation of coverage.

Definition of actual clientele
On the SNSF side, the analysis rests on an extraction of applicants who submitted an application during 2011 (Budgetdatum 2011) or benefitted from an ongoing grant in 2011 (start of grant on or before 31.12.2011; end of grant on or after 1.1.2011). The analysis is limited to project funding, interdisciplinary projects and Sinergia (Hierarchies Abteilungsübergreifend, Normal, Interdisziplinär, Sinergia).

Duplicates were identified by the person number, so that the quality of data should generally be good. Nevertheless some limitations apply. Discipline data, specified by applicants at the time of the proposal, is only available at the level of the project and not the applicant. Moreover structured data is only available for the main discipline. Therefore, only the main discipline was included in the analysis and it is assumed that it gives a good indication of the research field for co-applicants, too. Since SNSF data is not historicised, it is not possible to determine retrospectively whether a responsible applicant worked in Switzerland at a certain point in time. For responsible applicants in project funding and Sinergia this was assumed to be the case and responsible applicants remained in the data file regardless of the country of application or the country of their current institution. As far as possible only data of co-applicants was deleted and data of the responsible applicants retained in the data file, since the latter is considered more complete and reliable. Co-

applicants were excluded from the data file if their current institution was in a foreign country. As the information for co-application is not structured, a small number of persons from Universities of applied sciences or private institutions may not have been excluded from the analysis.

Possible extensions of the analysis
The group of 'customers' is defined rather narrowly, both in terms of instruments (project funding and Sinergia) and in terms of timeframe (applications or ongoing grants in 2011). This assumes that a researcher whose application was rejected will resubmit a project 12 months later. Including further schemes in the analysis or extending the timeframe during which an unsuccessful applicant is considered a customer would increase coverage. Reliable estimates are however difficult on the basis of existing data, since for the NRPs or NCCRs in particular, co-applicants are more likely to be active outside the research institutions and since these persons are difficult to identify with existing data.

The greatest limitation of the analysis is that it covers only one year. This is because some research institutions with a large number of researchers assigned to insufficiently specific FSO discipline groups were only able to provide detailed data for 2011. Previous analyses at a higher level of aggregation suggest that the coverage has decreased by 7% in Division III since 2007, remained stable in Division II and increased by 4% in Division I. An extension of the present, more detailed analysis to more years could provide further backing for this hypothesis. Moreover a timeline would serve as a test for the robustness of the analysis.

7.3. Topic Modeling

Portfolio Analysis: Assumptions

Our analysis is based on several assumptions. We first assume that a research field can be identified by a group of researchers who use a common vocabulary made of words and expressions. Even though different group of research might share a common subset of their vocabulary, we assume that a particular combination of words or expression defines a community of researcher.

In order to be able to compare fundraising and research activities of a given community, we must assume that researchers use the same vocabulary when writing a grant proposal and an original article in a journal. This assumption has some strong limitations: for instance, proposals might also contain descriptions of PhD educations, facilities needed for the planned research and rationale beyond the planned research ("we will save the world"). These sets of words are included in the semantic modeling, but excluded in the final definition of communities.

A third group of assumptions concerns the indicators used to address the definition of research and fundraising activity. We identify a research activity in a scientific domain with its productivity in terms of original publications. We restrict the analysis to the analysis of independent researchers, since this is currently an important eligibility criterion for submitting proposals to the SNSF. To do so, we only consider publications for which the corresponding author works in a Swiss institution. Limited access to bibliometric data restrict the reach of our analysis. It is very difficult to match SNSF applicants and authors of publications. We then limited the analysis of productivity in the aggregated level of scientific domains. Moreover, we are not in a position to access full data

by the entire international community. We could therefore not normalise potential differences in publication culture.

Several proxies for the fundraising activity might be considered. First, the number of proposals is a good indicator in groups of communities with similar fundraising habits. It is mainly the case in the life sciences where the rate of multiple submissions is very low. However, we shall restrain ourselves from using this indicator to compare scientific domains which submit to different evaluation committees. We might also use the requested budget as a good proxy. However, caution is called for. It is not clear to what extend requested budgets correspond to the true needs of a community.

We finally assumed that a reasonable comparison between both activities can be addressed by counting publications and grant proposals. The number of highly cited publications can also be considered as a secondary indicator. Again, limited access to bibliometric data forbids us to normalise citation cultures or to identify top cited publications (e.g. Top 10%).

Portfolio analysis: methodology

The SNSF developed a discipline list to define the research areas of projects it receives. It can only be mapped to other existing discipline lists with great difficulty. In order to enable comparative studies between research activities (publications) and funding activities (SNSF), a common classification must first be defined. To do so, we opted for a non-supervised classification using machine-learning technics known as Topic Modeling or LDA. This method extracts and assigns automatically topics to a document corpus. Several topics can be assigned to a single document, each of them being a weight.

Topic Modeling consists of several steps. First, a vocabulary of relevant terms must be set up. Second, topics must be extracted from a corpus of documents. A topic is defined as a distribution of words. In our pilot phase, we assumed that since the research in life sciences is very international, topics relevant to our analysis can be trained and fitted on a dataset of projects of similar funding agencies. These two preliminary steps were then performed by David Newman, from U. Urvine (now at Google) based on all proposals submitted to the NIH. He provided us with a vocabulary of approximately 160'000 terms and 870 topics. The semantic differences of these 870 topics can be tiny, implying a difficult interpretation of their content. To improve the interpretability of this topic model, we performed a clustering resulting into a second model containing only 200 topics. To do so, we used a cosine dissimilarity metrics of the topic-term distribution and applied hierarchical clustering with complete-linkage methods. Please note that this method always produces a reduced number of "garbage topics" made of words of lesser importance that evaded the original pre-processing, but enable the statistical approach to converge (topics 197-200 below).

We then inferred this topic model on two datasets of relevance to our analysis. First, we extracted 8400 proposals submitted to the SNSF since 2007 for which an abstract and keywords in English were provided and whose main discipline was in life sciences (discipline number > 30'000). Second, we extracted all published articles (no reviews) where the corresponding author is affiliated to a Swiss institution and for which the publication year ranges between 2008 and 2012.

Using Collapsed Gibbs sampling provided by the R-package LDA, we inferred the topics trained on the NIH proposals on the combination of abstracts, keywords and titles of all documents of our dataset[16]. The result is a distribution of topics for each project.

Finally, for each individual document, we keep the two most important research areas (with the highest weight), i.e. that each document is assigned to two different research areas. Each proposal or publication is therefore counted twice. Please note that we excluded the "garbage topics" and the insignificant topics (application, review, improvements) from the Top2 selection such that only scientific content is kept in the final semantic definition of the documents.

[16] We did not try to optimise the LDA-hyperparameters or the number of iterations, but arbitrarily choose them at alpha = eta =0.01, iter = 500.

Model 1 – 200 Topics

Topic_ID	Top 10 words
1	rna mrna translation proteins translational protein gene_expression transcripts ribosome posttranscriptional
2	training program career students skills faculty training_program trainees experience courses
3	pain chronic_pain chronic patients spinal neuropathic_pain sensory neurons treatment nociceptive
4	delivery gene_therapy vector vectors gene sirna therapeutic cells genes targeting
5	language speech english word children processing reading linguistic words learning
6	neurons neuronal brain cells neural neuron synaptic cns astrocytes neurogenesis
7	exercise physical_activity physical walking gait training disability mobility falls balance
8	mutations mutation genetic phenotype gene mutant mice mouse disease phenotypes
9	tuberculosis mtb m_tuberculosis mycobacterium_tuberculosis infection mycobacterial drug_resistant infected disease strains
10	injury tbi traumatic_brain_injury trauma sci recovery spinal_cord injuries injured patients
11	tumor cancer tumors cells metastasis treatment tumor_cells cancer_cells cancers therapy
12	hpv infection women vaginal cervical_cancer cervical hiv infections transmission genital
13	core projects center investigators program scientific cores administrative expertise management
14	infection infections bacterial host pathogens bacteria pathogen disease strains antibiotics
15	collagen ecm extracellular_matrix fibrosis matrix mmp fibroblasts tissue mmps remodeling
16	maternal pregnancy neonatal infants fetal women infant prenatal birth developmental
17	brain fmri neural neuroimaging regions mri neuroscience white_matter measures structural
18	signaling pathway signaling_pathways pathways molecular akt signaling_pathway signals kinase phosphorylation
19	cancer colorectal_cancer colon_cancer crc colon treatment oncology patients cancer_patients colorectal
20	diet dietary food intake nutritional nutrition foods consumption obesity diets
21	hiv hiv1 hiv_infection aids viral hiv_aids infection hiv_infected virus infected
22	spectroscopy mrs magnetic_resonance measurements spectroscopic noninvasive brain raman oxygen optical
23	surgery surgical procedures patients procedure patient minimally_invasive surgeons tissue surgeon
24	cells p53 protein cell_cycle overexpression proteins molecular knockdown mutant tumor_suppressor
25	exposure exposures exposed human chemical toxicity chemicals toxic risk air
26	million estimated united_states treatment cost billion disease costs patients population
27	proteins protein transport proteomic molecular proteomics trafficking mass_spectrometry cells nuclear
28	behavior behavioral behaviors social reward health interventions intervention learning attitudes
29	care healthcare patients patient health outcomes services treatment medical intervention
30	statistical technology problems single algorithms modeling apply framework methodology design
31	imaging mri image images tissue optical ultrasound detection contrast technology
32	lipid membrane lipids membranes fatty_acid signaling proteins metabolism plasma_membrane ceramide
33	transplant transplantation donor rejection graft patients organ recipients allogeneic allograft
34	detection assay device technology sample assays platform microfluidic diagnostic sensitive
35	receptor receptors antagonists ligands signaling agonists agonist ligand antagonist dopamine

36	bacterial bacteria microbial genes biofilm host virulence proteins human species
37	treatment patients therapy efficacy trial therapeutic therapies patient clinical_trials clinical
38	iron iron_deficiency heme ferritin transferrin iron_homeostasis iron_overload hepcidin proteins anemia
39	women estrogen female females male males reproductive ovarian sex estradiol
40	virus viral infection viruses influenza antiviral infected replication hcv host
41	intestinal mucosal gut ibd colitis intestine gastrointestinal mucosa inflammation inflammatory_bowel_disease
42	peptide peptides protein binding protease proteins cleavage proteases bind proteolytic
43	genes gene_expression gene transcription epigenetic transcriptional promoter molecular methylation chromatin
44	calcium intracellular_calcium calcium_signaling channels channel calcium_channels calcium_channel cells calcium_release calcium_influx
45	nitric_oxide nos inos nitric_oxide_synthase enos nnos parp1 nitrite nitrosylation l_arginine
46	ifn innate_immune cells tlr cytokine signaling cytokines receptors interferon th2
47	enzyme enzymes biosynthesis metabolism synthesis pathway biosynthetic metabolic pathways metabolites
48	anesthetic anesthesia anesthetics isoflurane ketamine drugs propofol action agents sedation
49	bladder urinary_tract bladder_cancer women urinary urine pelvic urothelial incontinence urinary_incontinence
50	community health african_american health_disparities ethnic communities african_americans disparities population racial
51	metabolic metabolism metabolites glucose metabolite enzymes metabolomic metabolomics enzyme glycolysis
52	efficacy drug dose phase_i treatment preclinical safety fda delivery phase_ii
53	dna repair dna_repair dna_damage replication dna_replication proteins damage cancer pathway
54	cell cells actin migration proteins cell_migration cytoskeletal dynamics polarity cytoskeleton
55	risk risk_factors cohort longitudinal prospective cardiovascular_disease cvd baseline population hypertension
56	parkinson_s_disease motor dopaminergic dopamine neurons pd_patients substantia_nigra symptoms dopaminergic_neurons neurodegenerative
57	disease sle patients autoimmune arthritis rheumatoid_arthritis lupus autoimmune_disease autoimmunity systemic_lupus_erythematosus
58	sequencing dna sequence genome genomic genes pcr sequences genetic samples
59	muscle skeletal_muscle muscles muscular_dystrophy myosin force skeletal fiber atrophy dmd
60	lung pulmonary lung_cancer lungs patients copd airway alveolar disease lung_injury
61	cells stem_cells differentiation stem_cell cell human culture tissue markers pluripotent
62	children child pediatric parents families parent family parental childhood age
63	inflammation inflammatory macrophages cytokine tnf cytokines macrophage proinflammatory anti_inflammatory il6
64	circadian clock oscillations frequency phase circadian_clock rhythms circadian_rhythms scn cycle
65	drug drugs cocaine treatment addiction abuse drug_abuse substance_abuse drug_use behavioral
66	telomere telomerase telomeres telomere_length telomeric shortening ends aging chromosome human
67	epilepsy seizures seizure epileptic patients brain eeg epileptogenesis hippocampal temporal_lobe_epilepsy
68	alcohol ethanol drinking alcohol_use alcoholism alcohol_consumption alcohol_abuse alcohol_related alcoholic exposure
69	compounds synthesis inhibitors chemical chemistry design analogs synthetic small_molecule molecules
70	software database users user access web researchers community computer tool
71	program expertise investigators team innovative clinical scientific center translational researchers
72	synaptic neurons neuronal synapses plasticity dendritic synapse brain spine molecular
73	schizophrenia symptoms patients ptsd treatment disorder symptom trauma psychiatric bipolar_disorder

74	genetic genes snps gene risk variants genotype snp genetics polymorphisms
75	visual perception processing neural attention perceptual stimulus spatial object objects
76	t_cell t_cells immune cells immune_system antigen tcr dendritic_cells immune_responses immune_response
77	autism asd children disorder social autism_spectrum_disorders behavioral autistic disorders neurodevelopmental
78	genes drosophila genetic yeast mutants screen gene c_elegans rnai mutant
79	cognitive social emotional performance attention cognition measures negative memory emotion
80	vascular blood_flow endothelial smooth_muscle arterial endothelial_cells arteries endothelium flow vessels
81	diabetes diabetic insulin type_2_diabetes glucose complications pancreatic islet hyperglycemia islets
82	spatial temporal dynamics dynamic patterns regions distribution location local region
83	biomarkers biomarker patients diagnosis diagnostic markers clinical disease patient treatment
84	phase_i phase_ii product technology commercial prototype milestone market milestones proprietary
85	glycan glycosylation glycans carbohydrate aptamers binding aptamer glycoproteins cell_surface structures
86	center facility expertise investigators instrument core medicine users equipment director
87	antibodies antibody anti human complement antigen antigens monoclonal_antibodies mab mabs
88	imaging pet fluorescence fluorescent microscopy image cells labeled probes gfp
89	bone osteoporosis skeletal osteoblasts fracture fractures osteoblast differentiation bone_mass osteoclast
90	nanoparticles materials surface nanoparticle polymer tissue material release cells delivery
91	toxin toxins anthrax botulinum bont lethal neurotoxin intoxication toxicity agents
92	molecular computational biological modeling disease network cellular networks pathways human
93	motor movement hand movements feedback robotic tasks performance arm task
94	integrin adhesion integrins chemokine migration chemokines signaling cxcr4 receptors receptor
95	structural structure domain protein binding proteins domains structures molecular residues
96	angiotensin_ii hypertension receptor ace ras angiotensin renin_angiotensin blood_pressure at1 hypertensive
97	prostate_cancer prostate pca androgen progression prostate_cancer_cells cancer psa human_prostate disease
98	parasite malaria parasites infection host disease mosquito infected vector transmission
99	breast_cancer breast women cancer mammary breast_cancer_cells breast_cancers her2 tumor breast_cancer_patients
100	cartilage joint osteoarthritis knee chondrocytes articular_cartilage chondrocyte injury pain joints
101	phosphorylation kinase camp kinases phosphorylated pka signaling phosphatase creb protein_kinase
102	asthma allergic airway inflammation allergen lung children ige mast_cells asthmatic
103	temperature thermal heat temperatures heating hyperthermia storage cryopreservation laser preservation
104	retinal retina vision eye visual amd glaucoma photoreceptor blindness photoreceptors
105	targeting antibody binding tumor imaging labeled radiolabeled antibodies anti conjugated
106	eye ocular lens corneal vision cornea cataract eyes visual lenses
107	disease patients als pathogenesis progression treatment onset clinical disorder progressive
108	health social survey neighborhood longitudinal economic population socioeconomic disparities measures

109	obesity obese insulin_resistance weight metabolic insulin overweight physical_activity diabetes adipose_tissue
110	vitamin_d supplementation dietary deficiency folate serum metabolism diet vdr status
111	cardiac heart heart_failure myocardial patients ventricular myocardium hearts cardiovascular ischemic
112	vaccine vaccines protection protective vaccination immunization protect antigens mice immunity
113	nfkappab ikk transcription_factor signaling kinase tnf pathway p65 genes inflammation
114	mice mouse knockout_mice gene genetic cre transgenic_mice wildtype transgenic knockout
115	cerebral brain stroke vascular csf patients aneurysm cerebrovascular intracranial hemorrhage
116	cholinergic acetylcholine ach muscarinic basal_forebrain neurons alzheimer_s_disease choline release chat
117	health online internet content web_based program media national interactive technology
118	rage advanced_glycation hmgb1 products end ages receptor age mobility inflammation
119	atherosclerosis atherosclerotic plaque vascular plaques coronary stent inflammation arterial progression
120	angiogenesis vegf endothelial_cells vascular angiogenic endothelial_cell endothelial blood_vessels growth vasculature
121	radiation dose treatment irradiation radiotherapy radiation_therapy radiation_induced tumor doses ionizing_radiation
122	assay screening compounds high_throughput screen assays hts inhibitors small_molecule small_molecules
123	epithelial epithelial_cells emt epithelium epithelial_cell cells transition tissue epithelial_mesenchymal corneal
124	animal animals rats rat humans species human primate monkeys nonhuman_primate
125	recovery jobs nih revision funds parent scope economy original economic
126	patients cells leukemia blood aml disease subjects circulating samples peripheral_blood
127	alzheimer_s_disease brain amyloid dementia app pathology tau disease mci aging
128	oxidative_stress ros reactive_oxygen_species antioxidant oxidative redox oxidation glutathione stress cells
129	stroke brain ischemic ischemia recovery acute treatment patients motor ischemic_stroke
130	company companies technology industry pharmaceutical market commercial academic products phase_i
131	microrna mirna mirnas mir targets genes mrna gene_expression noncoding_rna posttranscriptional
132	stress cortisol stressors psychological psychosocial stress_induced hpa_axis behavioral biological glucocorticoid
133	cox2 pge2 prostaglandin cyclooxygenase arachidonic_acid cox inhibitors inflammation pla2 prostaglandins
134	hypoxia hypoxic hif1 oxygen hif hypoxia_inducible_factor hif1a hypoxia_induced genes normoxic
135	zebrafish embryos embryonic developmental embryo defects genes vertebrate morphogenesis molecular
136	mitochondrial mitochondria mtdna ampk energy mitochondrial_dna atp cellular mitochondrial_membrane metabolic
137	sympathetic autonomic nerve peripheral nervous_system nerves neuropathy blood_pressure sensory cardiovascular
138	plant plants extracts compounds extract curcumin natural_products herbal medicine botanical
139	device design technology prototype monitoring devices phase_i patient monitor sensor
140	b_cell b_cells lymphoma ebv lymphomas cells antibodies antibody malignancies antigen
141	smoking nicotine smokers tobacco smoking_cessation quit cessation smoke tobacco_use abstinence
142	violence women offenders criminal_justice ipv abuse physical community treatment intimate_partner
143	cholesterol lipid hdl ldl plasma lipoprotein statins lipoproteins statin atherosclerosis
144	intervention treatment months efficacy interventions participants outcomes pilot baseline receive
145	liver hepatic hcc hepatocytes liver_disease hepatocellular_carcinoma hepatocyte cirrhosis liver_cancer patients

146	multiple_sclerosis cns eae myelin disease oligodendrocyte demyelination oligodendrocytes central_nervous_system demyelinating
147	dental oral tooth oral_health caries teeth dental_caries dentistry enamel dentin
148	platelet platelets thrombosis blood coagulation thrombin bleeding thrombotic hemostasis plasma
149	auditory hearing hearing_loss sound speech noise cochlear inner_ear acoustic hair_cells
150	image images imaging structure structures shape software segmentation structural registration
151	vocal speech song voice swallowing learning auditory disorders laryngeal vocalizations
152	lymphatic lymph_nodes lymph_node lymphangiogenesis lymph lymphedema lymphatics lymphatic_vessels sentinel node
153	autophagy autophagic degradation lysosomal proteins pathway organelles cellular accumulation lysosomes
154	disaster disasters louisiana natural orleans preparedness affected oil communities community
155	apoptosis cell_death apoptotic cells death survival caspase anti_apoptotic proteins pathway
156	mechanical force forces tissue strain mechanics stress cell stiffness biomechanical
157	skin wound wound_healing healing wounds keratinocytes epidermal cutaneous epidermis skin_cancer
158	isoforms isoform splicing alternative_splicing exon expressed mrna rna protein pre_mrna
159	renal kidney patients ckd disease hypertension kidney_disease tubular dialysis esrd
160	cortical neurons neural cortex brain sensory neuronal recording recordings visual
161	anemia blood scd rbc transfusion sickle_cell hemoglobin erythroid epo patients
162	memory learning hippocampus hippocampal behavioral cognitive brain fear memories deficits
163	mass_spectrometry mass water mass_spectrometer ion flow concentration size analytical chemical
164	decision_making decisions decision patient patients choice communication preferences choices behavior
165	pancreatic_cancer pancreatic ovarian_cancer ovarian disease pancreas patients survival adenocarcinoma cancers
166	countries international china global india country collaboration developing_countries health training
167	students school education student learning teachers science children schools educational
168	assessment measures quantitative measurement qualitative validity participants interviews clinical reliability
169	dietary prevention chemopreventive fatty_acids chemoprevention carcinogenesis cancer omega_3 agents fatty_acid
170	tissue specimens samples core tissues pathology collection clinical human investigators
171	safety driving workers drivers training injuries injury driver occupational worker
172	electrical electrodes electrode electrical_stimulation device implanted devices implantable frequency design
173	channel channels ion_channels ion_channel gating molecular currents membrane cells voltage_gated
174	adolescents adolescent youth adolescence age developmental prevention risk longitudinal substance_use
175	aging age age_related older older_adults aged young elderly lifespan decline
176	olfactory taste sensory odor receptor receptors olfactory_bulb odorant gustatory sweet
177	chaperone hsp90 hsp70 proteins chaperones heat_shock_protein hsp heat_shock protein heat_shock_proteins
178	veterans military combat personnel deployment war returning iraq ptsd afghanistan
179	depression depressed serotonin treatment mdd depressive_symptoms antidepressant suicide symptoms mood
180	oral periodontal hnscc periodontal_disease head_and_neck_cancer periodontitis oral_cancer head_and_neck patients oral_cavity
181	hypothalamic leptin hypothalamus neurons obesity hormone pituitary brain food_intake gnrh
182	nmr structure epr spin structural nmr_spectroscopy solution mhz labeled spectrometer

183	egfr igf1 signaling receptor growth_factor growth_factors growth receptors igf egf
184	mesothelioma pleural peritoneal malignant asbestos mesothelial cavity mpm cells exposure
185	sleep osa insomnia night sleep_apnea sleep_disorders circadian disturbances sleep_deprivation melatonin
186	zinc metal copper metals metal_ions zn2 ions metal_ion iron homeostasis
187	sperm male infertility reproductive fertility germ_cell fertilization embryo meiotic embryos
188	thyroid testosterone androgen hormone steroid thyroid_hormone hormones androgens thyroid_cancer steroids
189	opioid opioids morphine pain abuse drugs opiate addiction dependence analgesic
190	selenium selenoprotein selenoproteins sec thioredoxin selenocysteine supplementation reductase glutathione peroxidase
191	melanoma melanoma_cells melanomas skin melanocytes malignant skin_cancer human melanocyte metastatic
192	retinoic_acid retinoid vitamin_a rar retinoids trans atra retinol rxr signaling
193	cerebellar cerebellum purkinje purkinje_cells ataxia motor cell granule cerebellar_cortex fiber
194	notch notch_signaling pathway shh hedgehog signaling hh_signaling hedgehog_signaling notch1 ligand
195	mucin muc1 mucus mucins muc4 muc5ac surface epithelial human mucous
196	strengths weaknesses budget projects human_subjects requested justification commitment environment investigators
197	reviewers critique critiques meeting resume final note prepared applications section
198	nih http_www gov http org www edu lee section wang
199	page phs middle format rev ofthe background director applicant instructions
200	wit iia tat rti tde iib atr fet ies iiia