Synthesis of the results of the 2016 stakeholder consultation for Horizon 2020 Societal Challenge 5 'Climate action, environment, resource efficiency and raw materials'

Approved by : J. METTHEY, Director, RTD/I

2.0 version: J. ALQUEZAR SABADIE

Date: 12/07/2016

1. BACKGROUND

The European Commission launched on 18 February 2016 a stakeholder consultation to prepare the strategic priorities for 2018-2020 in the domain of Horizon 2020's Societal Challenge 5 'Climate action, environment, resource efficiency and raw materials' (SC5).

A short questionnaire was sent by e-mail to FP7 and Horizon 2020 project coordinators, National Contact Points (NCPs), Programme Committee delegates and other traditional stakeholders. It was also announced via Internet and through social media (Twitter, Facebook, Yammer), as well as at different events attended by the Commission services involved in the management of SC5. The deadline for submitting contributions was 8 April 2016.

In parallel to this stakeholder consultation, the Scientific Committee of the European Environment Agency (EEA) submitted an analysis of knowledge needs that would require further Research and Innovation (R&I) actions.

Box 1 presents the questions asked to stakeholders in the context of the consultation.

Box 1: Questionnaire of the stakeholders' consultation

1) What are the challenges in the areas of Societal Challenge 5 'Climate action, environment, resource efficiency and raw materials' that require action under the Work Programme 2018-2020? Would they require an integrated approach across the Horizon 2020 Societal Challenges and Leadership in Enabling and Industrial Technologies?

2) What is the output/impact that could be foreseen? Which innovation aspects could reach (market) deployment within 5-7 years?

3) Which gaps (in science and technology, innovation, markets, policy, financing and governance, regulation etc.) and potential game changers, including the role of the public sector in accelerating changes, need to be taken into account?

4) Which areas could benefit from integration of horizontal aspects such as social sciences and humanities, responsible research and innovation, gender aspects, international cooperation?

5) In view of the recent evolution of the socio-economic and policy context (see point 3 of this document), what are the emerging priorities for Societal Challenge 5?

This is the third time that Commission services have asked for stakeholders' feedback as input for the SC5 strategic priorities; the preparation of the SC5 Work Programme 2016-2017 included both a consultation and a call for ideas. The experience was judged to be a success, both in terms of participation and the quality of the contributions, which enriched the work programme.

In addition to the participation of the raw materials community in this consultation, the Operational Groups of the European Innovation Partnership on Raw Materials (EIP Raw Materials) held an ad-hoc meeting in April 2016 to discuss the challenges, gaps and priorities in the field for the next years. Summaries of this meeting can be downloaded from the EIP website (https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en). Consultations with other governance groups of the EIP (High level Group and Sherpa Group) are ongoing.

Overall, stakeholders welcomed the opportunity to provide their feedback and contribute to the preparation of the Work Programme.

2. PARTICIPATION DATA

The Commission received 211 contributions from stakeholders (compared with 139 during the first consultation two years ago). However, eleven contributions were repeated.

The majority of answers represented the official opinions of organisations and/or associations, as shown in Figure 1. One third of the proposals were made on a personal basis, generally by individuals working in universities, research centres, enterprises or other bodies linked with R&I and/or environmental issues.

Figure 1: Participation data, organisations vs. individuals

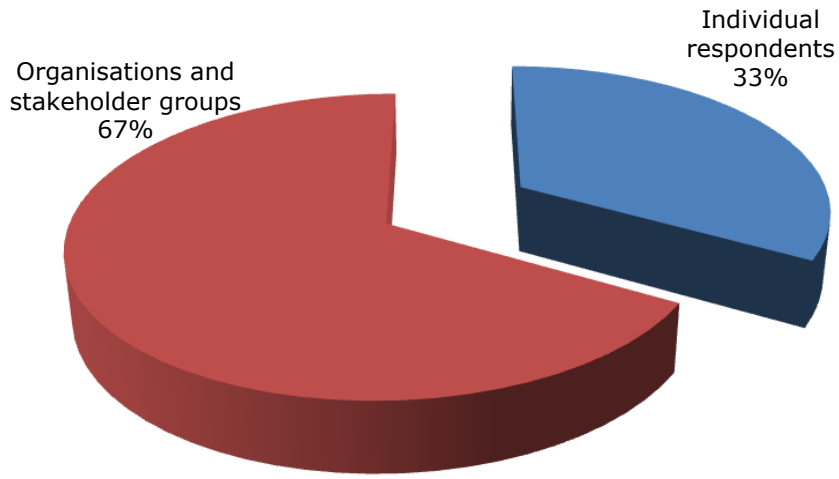


Figure 2 breaks down this information by the country of the organisation, or the place of employment of individual respondents. More than 50% of the contributions from organisations were from EU-level groups, such as European Technology Platforms (ETPs), Joint Programming Initiatives (JPIs) or professional associations. Organisations from the United Kingdom sent 16% of the contributions, followed by Belgium, Germany, the Netherlands and Sweden (8% each).

The proportions are different when individual proposals are considered. Italian (16%) and German (11%) respondents were the most active, before respondents based in Spain (6%), France (5%), Belgium (4%) or the UK (4%). Respondents from Eastern European countries remained under-represented.

Figure 2: Participation data, by country

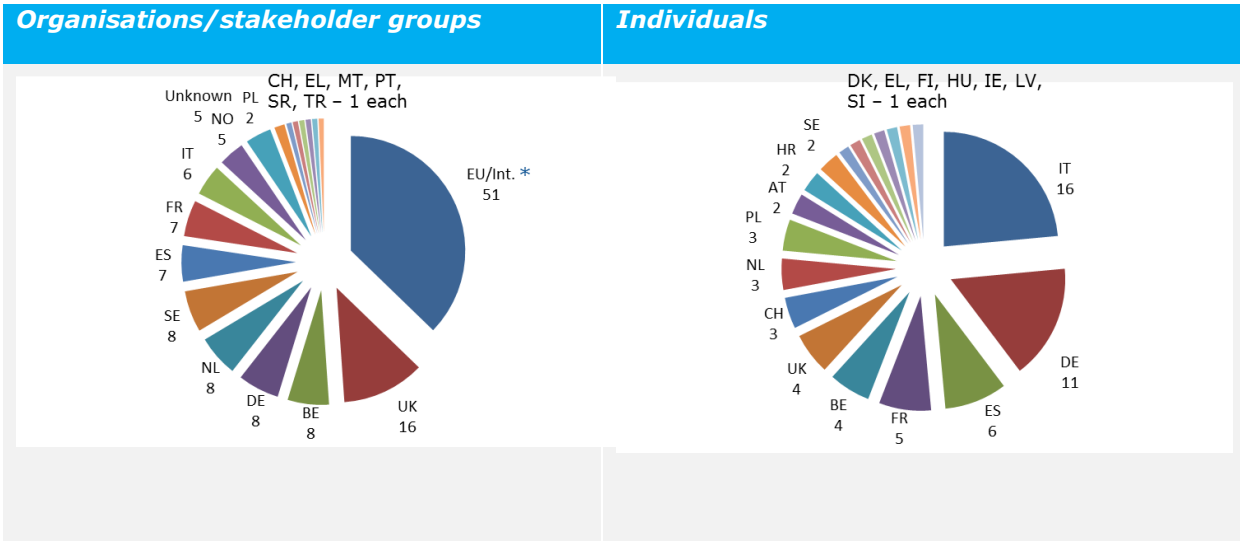
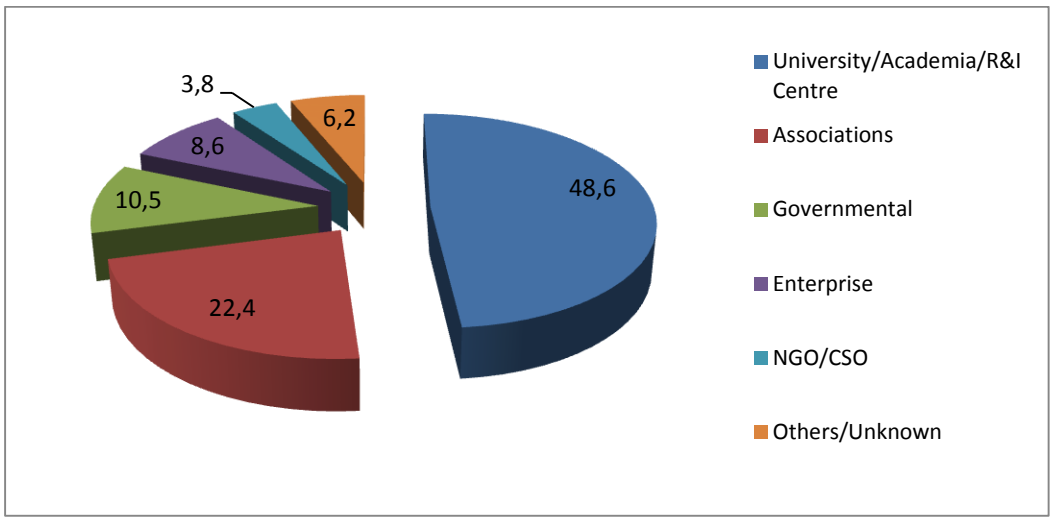


Figure 3 breaks down participants by the type of organisation they represent or work for. The vast majority of respondents belonged to universities, academic institutions or research centres, or to EU associations or groups of stakeholders. There were relatively few enterprises that responded directly to the consultation (fewer than 9%, as in the 2014 consultation) and even fewer NGOs/CSOs (3.8%, compared to 10% in 2014).

Figure 3: Participation data, by type of organisation



3. GENERAL TRENDS

It is worth remembering that this consultation is not a representative survey of stakeholders' opinions. Respondents have not been selected randomly; it was their own decision to contribute or not. This means that different sources of bias are possible in the feedback received: people/organisations that are already beneficiaries of Horizon 2020 or previous Framework Programmes or who know Horizon 2020 and SC5, lobbyists who defend certain areas of intervention, R&I communities with more capacity than others for mobilising a

response, etc. The qualitative dimension of the contributions (i.e. their content) is therefore more relevant in the analysis than the quantitative dimension (i.e. statistics).

3.1. Main characteristics of the contributions

Contributions were generally between 4 and 6 pages (some going beyond 10 pages), normally presenting a broad view and not going into details (exceptions are mentioned in point 5 below). In general, stakeholders appeared to support the existing SC5 strategic choices and narrative. Moreover, sound quantitative arguments for possible areas of priority intervention for the future Work Programme which would diverge from the overall approach hitherto were not extensively presented. In limited cases, contributions were more a kind of 'shopping list' or 'mixed bag' of issues.

Respondents appeared well aware of EU policy lines such as the circular economy, the need for systemic/integrated approaches, the relevance of promoting multi-disciplinarity or new business models. The Sustainable Development Goals (SDGs) were on occasions mentioned to justify certain areas of intervention. Some contributions defended specific areas like cultural heritage or raw materials. There was consensus on the role of (innovative) public procurement and standardisation as facilitators for the uptake of new solutions; regulation and taxation issues were also mentioned, although rarely.

The content of contributions was generally less analytical than those responding to the consultation launched in 2014 to support the drafting of the SC5 Work Programme 2016-2017. Few answers included quantitative descriptions of the state-of-the-art, leading to an analysis of knowledge or innovation gaps, and then suggesting recommendations for the next Work Programme.

The 'overview' nature of the contributions received may be due to factors such as:

- the character of the questionnaire:
- the absence of an orientation paper. In contrast, the stakeholder consultation launched in 2014 was accompanied by a policy paper drafted by the Horizon 2020-SC5 Advisory Group, which already indicated some main intervention lines (e.g. Nature-Based Solutions, Climate Services, Systemic innovation) and their rationale, which helped stakeholders to orientate their contribution;
- most respondents were beneficiaries of Horizon 2020/FP7:
- the communication campaign on the stakeholder consultation held in 2014 proved to be more successful in attracting "new" stakeholders.

3.2. Tensions expressed

Several valuable contributions were received, which included an analysis and subsequent recommendations. An overall reading of these show some tensions between the nature of the R&I actions proposed:

Continuity of R&I actions or completely new actions?

Some contributions do explain the state-of-play in their respective area and then define the R&I needs. In some few cases stakeholders narrow their focus on the next steps of ongoing projects, but generally the visions are broader. For example, one respondent insisted on the need to maintain a "sustainable investment level" in areas like earth observation, climate science, and technologies like data storage.

This raises a relevant question for the preparation of the Horizon 2020 Work Programme 2018-2020: To what extent should the continuity of R&I in areas already supported (like

nutrients, polar research, ecosystem services or even nature-based solutions and climate services) be ensured? Or should the Work Programme privilege investments building upon results of on-going projects?

Knowledge creation (i.e. traditional research) versus solutions (i.e. innovation, especially technological) versus accompanying measures (i.e. meta-analysis, studies or CSAs):

Many respondents focused on research (for instance, in areas like Arctic/Antarctic research, on climate change or on marine), while others were more solution-oriented (e.g. valorisation of wasted water beyond irrigation, new uses of wood, improvement of raw materials processing, new sensors for earth observation, application of earth observation data).

Many contributions supported meta-analysis activities, like "*Analysis of supply chains and their opportunities of integrating direct and reverse flows going from a supply chain management to a supply cycle management*", "*Identify and build models that increase the global efficiency of supply chains and understand how flows that currently operate separately could be made seamless*", "*Designing realistic and cost-effective decarbonisation pathways for the EU, for its neighbourhood and for developing countries*" or even foresight studies or projects.

A few contributions strongly defended the role of "knowledge brokers" or "knowledge and technological transfer organisations", which do not create new knowledge or develop innovations but rather translate and digest others' findings to policy-makers. There was no consensus on the relevance of this sort of meta-analysis and bodies. Indeed, one stakeholder felt that excessive resources had been devoted to innovation studies, which are neither innovation nor research.

It should be noted that the *Ex Post Evaluation of FP7-Environment* considered that the policy impact of CSAs was not always demonstrated, whereas the use of this instrument for networking and creation of R&I communities was deemed positive. However, in this consultation, stakeholders more frequently supported the former than the latter.

3.3. Critiques of European Commission R&I policy

A few stakeholders included in their analysis a critique of the Commission's R&I strategies and policies. Three judged the current support to ERA-NETs, Public-Private Partnerships and similar co-funding instruments to be excessive and considered that the proliferation of such instruments was leading to a level of fragmentation that challenges the added-value of the EU's R&I investments. They called for better coordination and to use them more sparingly.

Other respondents considered that SC5 has been neglecting science. They did not criticise the current focus on solution-oriented innovation and large scale demonstrations as such, but argued that any advancement requires novel knowledge creation, monitoring and understanding. Science is therefore the pillar of future growth, since without it future innovations would be unlikely.

One respondent expressed the opinion that the use of terms like "Nature-Based Solutions" or "Ecosystem Services" in narratives which aim to underline the economic benefits of nature can have counter-productive effects and lead to policy-makers forgetting the importance of defending nature *per se,* losing the focus on environmental issues and making nature a purely economic object.

Along the same lines, another contributor asked the Commission to stop using 'smart terms', which were potentially unintelligible, since it was felt that these introduced 'noise' and complexity in the calls for proposals and obscured their focus. This was seen to be contrary to simplification.

Finally, stakeholders from the water community considered that their sector did not have enough visibility in Work Programme 2016-2017, where water was mainstreamed in the various other areas instead of including all water-related topics under a single call.

4. MOST RELEVANT AREAS/PRIORITIES PROPOSED

The **water-energy-food-(health)** nexus was one of the domains most frequently quoted (health was not always included in the contributions supporting the "nexus), not necessarily only by traditional water stakeholders.

In line with the focus on integrated approaches, ideas proposed on the nexus combined technological development, monitoring, evaluation and forecasting, and governance measures. A health component was sometimes included in this, with stakeholders highlighting the need to monitor pollutants and assess their impact on human well-being. There was a relatively high demand for synergy between Societal Challenges 1 (health), 2 (bioeconomy) and/or 5, linking water and food, or marine and earth observation, or even climate, food and health. This synergy was considered by one respondent as not being covered under Horizon 2020, differently from FP7.

Contributors proposed the following areas of intervention:

- development of new materials, like nano-membranes and biotechnologies for water sanitation;
- development of new processes, e.g. smart precision agriculture, energy-neutral or positive water infrastructures;
- monitoring of micro-pollutants in water and development of new treatments to eliminate them;
- re-use, recycling and valorisation of water, beyond the traditional irrigation use; for example, valorisation of nutrients or harvesting energy captured in residual water streams;
- development of decentralised water supply and sanitation systems, similar to those being increasingly used for energy supply; phenomena like urban farming were also connected to this general tendency. While decentralised water sanitation systems are currently used in poor or remote areas or after catastrophes (e.g. in refugee camps), respondents mentioned decentralised water sanitation and supply in a broader context, for example for more sustainable cities;
- Earth observation, including citizens' science tools, as a tool for water monitoring and management; this reflects strong stakeholder demand for the operational use of Earth observation data in various sectors but particularly for water;
- a Global Monitoring Platform of Water Quality, including satellite data, was proposed by one respondent;
- Managed Aquifer Recharge (MAR) from surface water, spring overflows, etc.

Stakeholders considered access to **raw materials** as a prerequisite for moving towards a low carbon and digital economy and for the creation of new jobs in different industries. According to several stakeholders, since Europe lags behind the leading countries in managing/producing raw materials, the EU has a duty to increase its long-term efforts on multidisciplinary R&I in order to secure a sustainable supply of raw materials. Some stakeholders suggested applying a counter-cycle vision to reduce the risks of future disruptions to supply by investing in innovation when commodities prices are low.

Stakeholders identified important opportunities and needs in areas like:

- developing innovative and sustainable land-use planning;
- an integrated knowledge base on long-term sustainable uses of the geological underground (including offshore underground) to support well-informed governance and decision-making;
- an integrated approach for new discoveries of primary and secondary raw materials deposits based on novel multidisciplinary exploration technologies, different data sources and modelling; this would include the exploitation of harmonised and transparent big data on raw materials flows to optimise sourcing in the EU;
- further developing a whole value-chain approach from exploration to metals/minerals production, using potential of by- or co-products of complex, low-grade raw materials matrixes and including more flexible and efficient processing and reprocessing of tailings and wastes. This would include an improved valorisation of different waste streams, the enhanced recovery of critical and rare metals from end-of life products and the need for increased energy and resource efficiency of all operations.
- the increasingly important role of automation and digitisation of operations in raw materials industries.

Some contributions called for further support to activities on substitution of critical raw materials. It was stressed that solutions in this field will require an integrated approach to strengthen collaboration between researchers working in different areas such as materials science, modelling or product design. Respondents suggested applications of critical raw materials that were in line with the Strategic Implementation Plan of the EIP (e.g. catalysts, magnets, touchscreens or alloys).

Stakeholders also underlined the importance of social aspects:

- understanding public acceptance (including cultural and regional differences); some respondents supported the introduction of a social licence to operate;
- awareness raising and involvement of citizens, requiring collaboration with social sciences to understand the behaviours of different actors (e.g. researchers, innovators, consumers or decision-makers) and to facilitate long-term thinking for a sustainable raw material supply.

Respondents pointed out that the implementation of innovative technologies for the production of primary and secondary raw materials still required work on standards and the regulatory framework. In particular, stakeholders considered that it was essential to improve the legal framework for waste management to support innovation and investment and to facilitate the re-use of secondary raw materials. Stakeholders also mentioned the need for further international cooperation with raw materials producing countries.

Stakeholders underlined the huge opportunities in the **operational use of Earth observation data** (i.e. GEO and/or Copernicus). Earth observation data were frequently presented as a necessary tool in areas like water, forest management, marine, climate change or raw materials. Their potential use and further needs were described in detail by respondents, including:

- capitalising on gravity data to measure and map ice mass balance, glacier melt, land use, or to establish early warning systems for floods;
- providing global non-invasive, accurate maps and models of land surface composition and conditions for raw materials; similarly, the valuation of ecosystem services requires more geographic information data at a higher resolution;
- developing sensors (and networks of sensors) to improve Earth observation, both from space and in-situ, for environmental monitoring;

- the role of social media, crowdfunding and data analytics;
- some stakeholders called for more coordination, including focus areas, with LEIT;
- strong support for Citizens Observatories and Citizens Science, seen as a solution for collecting in-situ data at lower cost.

Those contributions showed a strong demand for developing new products, services and real-time solutions from Earth observation data, implying that GEO should deliver results that could be operational almost directly. Stakeholders considered that a real operational use of Earth observation would provide sectoral advantages for users as well as maintaining or even increasing European competitiveness in the Earth observation and space sectors.

Nutrients were also another popular topic in responses. There was a large consensus on the need to re-use and valorise nutrients from water and other by-products, which was justified in relation to the Circular Economy narrative. In this area, stakeholders called for demonstrations at the highest Technology Readiness Levels (TRLs). Other sources of recovered nutrients would be manure, biogas digestates and bio-energy, or sewage sludge incineration ash.

Respondents also recognised that while technologies are ready in areas like manure and sewage, their mainstreaming requires new supporting policies, economic models and time, since the cycle of infrastructure renewal is long. Other barriers to the management, recovery and valorisation of nutrients were mentioned, such as consumer diet choices or societal rejection to organic waste recycling in agriculture. There was also a passionate defence of dry sanitation by one respondent. Traceability of organic waste, to enable risk management and increase public awareness, was seen as a solution to helping modify citizens' behaviour.

In line with the Circular Economy rationale, which was quoted and strongly supported by stakeholders, **recycling of food waste** appeared as another emerging issue. Making food waste a resource was considered a need, but stakeholders did not suggest concrete solutions beyond its (traditional) use for soils. Respondents considered that food waste should be better measured.

Climate change and **Polar research** are the areas where stakeholders provided the most detailed and analytical contributions, sometimes of very technical nature. These touched on:

- climate impacts at 1.5°C vs. 2°C;
- accounting of mitigation measures and geo-engineering;
- 100-year forecast modelling of atmospheric processes;
- the role of CO2 and CH4 emissions of geological origin;
- better climate sensitivity estimates;
- better forecasting at a scale of 5-7 years, and local information;
- Earth system modelling;
- seamless projections.

The need to develop climate services, a core strategic priority in the Work Programme 2016-2016, was mentioned by only a few respondents. Instead, climate change modelling was an area where continuity of research investments was clearly demanded, accompanied by descriptions of very specific research gaps. Various stakeholders considered that a key knowledge challenge was to improve predictions at local scale, in order to enhance disaster resilience.

Several stakeholders requested further research on paleo-climate, which was presented as a typically multi-disciplinary domain, with experts on physical climate, biogeochemistry (i.e.

vegetation, soils, marine flora and fauna), historians and archaeologists. According to these contributions, paleo-science could improve climate change predictions at local scale.

Related to climate change, **hazards** appear very often in the consultation constantly, even if not always with a detailed analysis of the knowledge or innovation needs nor with concrete suggestions. Stakeholders mentioned that tools, standards and protocols (e.g. early warning systems) should be further developed, and that more research is needed on the impacts of climate change on soils, coastal erosion, pollution, water provision, etc. There was a certain focus on risks in urban settings.

Arctic/Antarctic research was seen as another key component for understanding and addressing climate change. A few respondents considered that it would be an ideal topic for synergies, because it combines understanding of climate change (e.g. study of climate history), technology development (polar research is compared with space research because of its technological impacts) or new perspectives on pollution (e.g. what are the effects of new maritime routes and extractions?). It was also considered to be a potential area for public-private partnerships, thanks to the combination of economic potential, technological development and research needs. Respondents highlighted a number of knowledge gaps in polar research, for example:

- understanding of biogeochemical process in the polar regions during the dark (winter) season; most research is currently conducted in the much more accessible summer season, even if the photochemistry of the atmosphere and the oceans plays a crucial role for the cloud formation, biogenic activity, etc.;
- Arctic Ocean variability and changes related to climate change, for better predictability.
- better quantification of the anthropogenic (and natural) sources of pollution and better characterisation of transformation processes and their impacts on the physical environment (atmosphere, ocean, cryosphere, soils, lakes) and on local populations in the Arctic region;
- assessing the impact of economic activities in different sectors (ports, land and sea transport, extraction of mineral resources and hydrocarbons) on the environment and on societies.

Biodiversity and **ecosystem services** were mentioned in several contributions. Respondents considered that there are still knowledge gaps both in understanding their functioning and socio-ecological-economic interdependencies, and in their valuation, either in specific domains like marine or in terms of specific ecosystem services (e.g. cultural ones). This would require, *inter alia*, testing recent advances on molecular methods for taxonomic identification, use of eDNA, physicochemical sensors, etc. to assess ecological status and trends.

Respondents defended the importance of supporting **cultural heritage**, especially in connection with sustainability. They underlined the need to revalorise historical buildings and brownfield sites, or to improve energy efficiency in museums and galleries. Stakeholders were concerned with the impact that climate change and increasing environmental pressures can have on cultural heritage resources, including those situated in coastal areas or even underground ("buried archaeological materials"). Another emerging area of concern was digitisation, including the sustainable management of digital heritage. Respondents advocating cultural heritage R&I remained focused on the problems and rarely proposed concrete solutions.

- Among the contributions most focused on technological innovation, some respondents presented visions on how traditional sectors could develop to maintain their competitiveness. For instance, the **forest and paper sectors** should look for new products and markets, including via:

- sustainable textile production from wood, in view of increasing water scarcity and peak production of cotton;
- exploring the possibilities of wood for food or feed;
- increasing the re-usability of wood composites;
- more use of wood andpaper-based materials in building construction, as substitutes for concrete, styrene and other conventional construction materials;
- bio-based composite materials including paper reinforcement fibres;
- re-use of waste streams from forest residues for new materials and products (e.g. textiles);
- recycling biomass waste to extract nutrients;
- paper-based packaging solutions, to replace CO_2-intense products.

These are interesting examples of how one sector can develop through innovation, looking for new products and markets, based on long-term visions. Most of the proposals focused on specific technologies instead of large-scale demonstrations.

The need for further work on biotic raw materials such as natural rubber was also mentioned by one stakeholder who asked for research and cooperation to improve the recovery and reuse of rubbery materials from end-of-life tyres or to diversify the sources of natural rubber for Europe.

Few contributions explicitly supported the continuation of efforts in areas that were priorities in the Work Programme 2016-2017, like **nature-based solutions**, in particular in cities, or **climate services**. Nevertheless, **cities** were very frequently mentioned indirectly in references to other areas of intervention, for example, when referring to water issues (ensuring sanitation and distribution, valorisation, sustainable drainage systems), raw materials (urban mining), hazards linked to climate change, air pollution, cultural heritage etc.

Indeed, two respondents considered that the Work Programme should give emphasis to local solutions instead of European-wide ones, since they felt that local solutions are the only ones able to address environmental and climate challenges adequately.

It is also interesting to observe that some respondents identified new R&I linked to those domains. For example, one respondent mentioned exploring "urban plant physiology", to identify plants that adapt best to the urban environment they are exposed to, in order to maximize their environmental benefits.

The concept of **Big Data** appeared constantly in contributions. A large number of respondents mentioned its potential for science and innovation, but nothing precise was proposed, nor were concrete ways to solve problems described.

Finally, several stakeholders raised the importance of **education**, particularly with regards to encouraging collaboration between researchers, school teachers and pupils to change mind-sets on climate change and environmental issues.

5. ISOLATED PROPOSALS

- In some cases, contributions were submitted by a single respondent and included a high level of detail, including the following:
- "Low intensity agriculture": In Europe, there are several areas of fertile soil that farmers have abandoned due to difficult access (i.e. in hills/mountains). One respondent highlighted this in the context of sustainable food production and

biodiversity, arguing for R&I to find formulas for encouraging the sustainable re-exploitation of this land.

- Research on biodiversity and climate change in mountain areas, including better monitoring and indicators. This should include mountain ranges which are often neglected such as the Pyrenees, mountain ranges in Britain or the Apennines.
- Further development of cement, concrete and paving materials, to ensure more durability and fewer emissions in their production (for example, by mainstreaming waste heat recovery systems). Technologies exist, but standardisation is still needed.
- Inductive/contactless charging of electric buses via elements embedded in the pavement
- Development of bat- and bird- friendly wind energy turbines.

6. CONCLUSIONS

The consultation has allowed stakeholders to express their views and contribute to proposals for Work Programme 2018-2020. It indicated on the one hand the responders' substantial support for the evolution of the previous two SC5 Work Programmes, in line with the spirit of Horizon 2020, from a collection of research actions funded to a policy-driven, strategic investment in a portfolio of solutions. On the other hand, the balance between support for traditional research and for solutions-oriented innovation projects was appreciated differently. Moreover, a strong call was registered for a number of well-framed accompanying measures to carry out studies and analysis for better understanding the fast-evolving reality and effectively targeting future action. However, it should be noted that the *Ex Post Evaluation of FP7-Environment* considered that the policy impact of CSAs was not always demonstrated, whereas the use of this instrument for networking and creation of R&I communities was deemed positive. Some stakeholders also warned against a proliferation of new ERA-NETs, Public-Private Partnerships and other co-funding instruments, due to a perceived risk of fragmentation.

The importance of the circular economy was mentioned extensively, as was the need for systemic/integrated approaches, promoting multi-disciplinarity and new business models. The Sustainable Development Goals (SDGs) were sometimes mentioned to frame the EU intervention. Various contributions highlighted the relevance of individual areas such as cultural heritage, re-use and recycling of raw materials, food and nutrients, climate change and big data. There was consensus on the role of (innovative) public procurement and standardisation as facilitators for the uptake of new solutions; however, the potential role of innovation in regulation and taxation – albeit mentioned – were not articulated with operational details.