Rewarding RRI

A case study collection
of the European Foundations
Award for Responsible Research
& Innovation 2016

Colophon

Contents

1. Introduction

The European Foundations Award for Responsible Research & Innovation (EFARRI) aims to identify research groups that have successfully incorporated methods to align research with the needs of society and contributed towards the development of a smart, inclusive and sustainable society. The award is a joint initiative of the King Baudouin Foundation (Belgium), "la Caixa" Foundation (Spain), Fondazione Cariplo (Italy), the Lundbeck Foundation (Denmark), the Robert Bosch Stiftung (Germany) and the European Foundation Centre Research Forum. Together they launched this call in September 2015 in the framework of support for Responsible Research and Innovation in the European Research Area.

Today's society is facing many challenges, ranging from ageing populations to the increasing need for smart healthcare systems and a sustainable supply of energy and water. Scientific research and technological progress allows for new innovations that can address such societal challenges. While proposed solutions may bring certain benefits to users, developed technologies may also require sacrifices by the users. Consider for example the benefits of increased ICT use vs. data privacy. People other than users may also be affected by the impacts of technology. For instance, while the benefits of a new wind farm are for society as a whole, local communities may experience burdens, for instance from visual pollution or noise. This means that innovations raise moral questions, such as what is a fair distribution of the costs and benefits of an innovation, or who should be responsible, for example, for safeguarding the privacy of individuals? Such moral questions can have repercussions for successful implementation of innovation. An unfair distribution of costs and benefits may, for instance, lead to opposition between stakeholder groups, often giving rise to significant delays in implementation of an innovation or even causing its demise.

'Responsible Research and Innovation' (RRI) is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim of fostering the design of inclusive and sustainable research and innovation. RRI stimulates the accountability of research and innovation to funders and to society as a whole.

The methods and practices used to carry out RRI differ from more traditional methods for conducting research and innovation. After all, RRI requires the inclusion of diverse stakeholders, anticipation and reflection on multiple values, open and transparent communication and the ability to respond or adapt based on feedback that is received in order to accommodate the wider range of stakeholders and their viewpoints that exist both now and in the future.

The foundations that have initiated EFARRI intrinsically endorse and stimulate the values that are conveyed by RRI. As research funders they are in a position to define the conditions under which this research has to be carried out. The EFC Research Forum Statement on RRI underlines the importance of promoting RRI not only at the level of individuals and projects, but also at the level of institutions and their practices. "It should be the responsibility of both the foundations and the institutions they fund."

The launch of EFARRI can be seen in this light: in order to produce broad and lasting impacts the implementation of RRI and inspiring practices that already exist should be surveyed, articulated and disseminated across Europe and beyond. The award intrinsically stimulates researchers to reflect on their work in terms of RRI and up to now it is the only large financial incentive for RRI uptake in research.

This report presents the fifteen projects that were shortlisted by a jury after a thorough analysis of the RRI dimensions and research approaches of each of the projects. The analyses presented in the case studies are the result of lively and constructive interview sessions held by members of the scientific committee with the finalists. This scientific committee, also the authors of this report, consists of a multidisciplinary group of scholars from different research groups at Delft University of Technology, the Netherlands, all with a track record in the area of RRI. In addition to the interviews, the analyses presented in this report result from intense discussions between the scientific committee, the members of the jury and the experts that were consulted to develop a framework for analysis.

Before presenting each of the fifteen finalists, the procedure that was followed to select these fifteen nominees will be explained. The work of the finalists and laureates can be seen as setting an example for RRI. Their original and deeply embedded approaches may inspire future researchers and innovators to anticipate and assess potential implications and societal expectations with regard to research and innovation in their own projects.

2. Process and methodology

The process and methodology used to identify the winning research teams for EFARRI followed a structured approach based on eight distinct steps. Each of the steps is explained below.

Figure 1. Overview of the eight steps to select the winners

1.	Structured Literature Review
2.	Developing the application form and announcing the award
3.	Expert workshop
4.	Selection procedure
5.	Case study development
6.	Selection of the award winners
7.	Award Ceremony
8.	Publication and dissemination
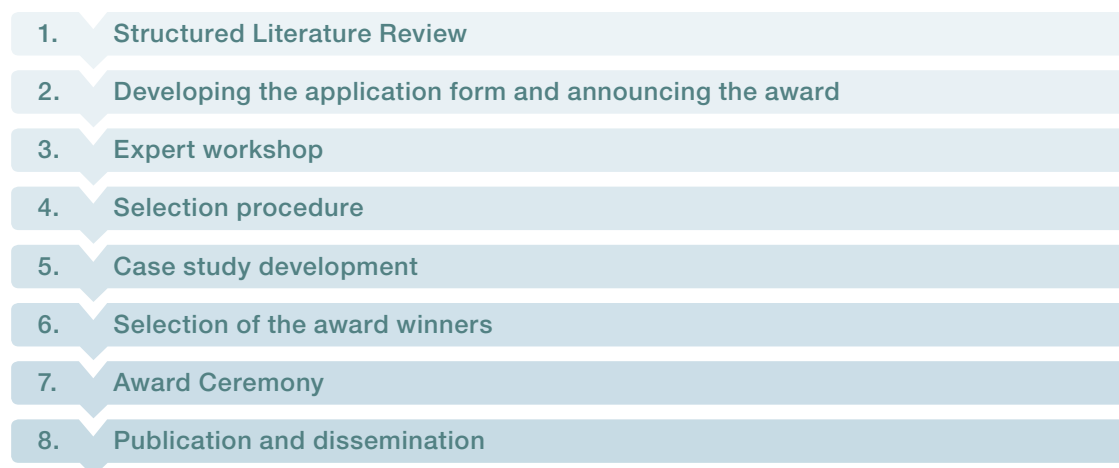
Step 1. Structured Literature Review

The first step was the Structured Literature Review (SLR) which was conducted to identify indicators in previous research that could be used as criteria to assess the extent of Responsible Research and Innovation among research groups. The SRL draws on an investigation of published papers in international journals, book chapters and papers presented at conferences. The structured literature review was carried out in two stages. The first stage was during summer 2015 to develop the criteria for the application form, and the second stage was in preparation for the expert meeting, where the guidelines to assess the input provided by the candidates were defined.

Step 2. Developing the application form and announcing the award

The second step concerned developing the application and preparing for announcement of the EFARRI award. Some research groups may be more familiar with the concept of RRI and its various dimensions than others, while in the conduct of their innovation even those unaware of the RRI concept may well be performing according to the concepts of RRI. The intention in this step was consequently to develop the application in such a way that research groups that have not explicitly adopted the RRI concept would still be eligible to apply for the award. This also allowed for the identification of new practices that can be considered relevant to RRI. The application form therefore included general and open questions and asked the applicants to formulate their projects in relation to RRI in their own words. Applicants were also asked for examples and facts to support the answers provided. Box 1 shows the questions in the application form. Applicants additionally provided their contact details, their organisation type, the responsible person within the organisation, general information about the project and where it was conducted, and they were able to enclose some appendices to provide more detail.

Box 1. Questions in the application form

1. Description of the research

2. Objective

3. Impact

4. Contribution to RRI (six specific questions)

    a. Please explain how your research contributes to a societal problem.

    b. Please explain how and to what extent you have involved target groups, audiences and stakeholders relevant to the outcome of the research project.

    c. Please explain how you communicated with target groups, audiences and stakeholders relevant to the outcome of the research project.

    d. Please provide insight into the impact and evaluation of Responsible Research and Innovation practices.

    e. Please explain to what extent your project acts as an interesting model to replicate and for which interest groups it might be interesting.

    f. Please indicate how and in which domains you could improve your research to make it even more responsible and how you would use the Award prize money to do so.

To raise awareness of the award a [flyer](#) was produced and distributed to various research groups, such as the members of RRI Tools partners and Hubs, various European research networks, the National University Associations across Europe, a number of foundations, and various LinkedIn groups as well as through direct e-mails to the coordinators of FP7 projects in Energy, Health and Science in Society.

The flyer was finalised in late August 2015 and explained the following criteria, based on the insights developed in the [RRI Tools project](#):

1. **The scientific quality and results obtained to date by the researcher or research team**

2. **Successful integration of the RRI process dimensions at various stages in the research:**

    a. **Diversity and inclusion:** the research must involve a wide range of stakeholders (researchers, citizens, policy makers, industry, educators, etc.) throughout the research process, relevance of the involvement and engagement methodology at different stages, attention to and respect for differences.

    b. **Anticipation and reflection:** the research should incorporate an adequate analysis of the background (societal role, diverging problem definitions etc.), addressing ethical, legal, social and/or environmental aspects, envisioning plausible futures and facilitating deliberation on values, perceptions, needs and interests, now and in the future.

    c. **Openness and transparency:** the research should communicate appropriate, honest and clear information about processes, roles, content and results and give transparent public information in order to facilitate fast innovation, constructive collaboration among peers and productive dialogue with civil society.

d. Responsiveness and adaptive change: the research should have the flexibility to change practices in response to feedback, new circumstances, insights and values of stakeholders and the general public.

3. Replicability of the methodology

The website for submission of applications was open between September 14th and December 7th 2015. In total 367 applications were started, of which 211 were completed and submitted.

Step 3. Expert workshop

Based on the Systematic Literature Review (SLR) a list of indicators for RRI was developed. The list formed the input for an expert workshop held on December 3, 2015. The expert workshop was chaired by Prof. Jeroen van den Hoven and the participating experts were Prof. May Thorseth from the Norwegian University of Science and Technology, Prof. Silvio Funtowicz from the University of Bergen, Dr. Vincent Blok from Wageningen University and Dr. Aad Correljé from Delft University of Technology. These experts represent various research backgrounds. The objective of the expert workshop was to develop assessment criteria for analysing the input provided by the applicants. The wide-ranging indicators discussed at the expert meeting were clustered according to the four dimensions of RRI as identified by Stilgoe et al. (2013): anticipation, inclusion, reflexivity and responsiveness. A cross-cutting indicator was added to assess the extent to which a particular RRI feature was structural (e.g. deeply embedded throughout the whole duration of the project rather than on an ad-hoc basis or at a particular moment).

Step 4. Selection procedure

The selection procedure aimed to reduce the total number of 211 applications and select the 15 finalists to visit on site for further in depth analysis. The selection procedure was based on an eligibility check and three subsequent selection rounds.

1. Eligibility check (211 > 196)

The assessment of eligibility was conducted between December 10 and 16, 2015. Four assessors from the Foundations were involved and each submission was analysed for eligibility by two assessors based on the following criteria:

- The scientific research project or research programme is conducted by a university, research centre, industry, civil society organisation or other type of organisation,

- The research coordinator must be located in the European Research Area,

- The research must be ongoing or must have been finalised no earlier than 2013,

- The coordinator of the research and his/her team must agree to participate in a case study analysis if shortlisted by the Award Committee (jury),

- The research team endorses the European Code of Conduct for Research Integrity.

The eligibility check resulted in 196 eligible applicants (see Table 1) that were further analysed by the scientific committee.

Table 1. Number of applications per country per selection round

	Final submissions	Eligible submissions	First preselection	Second preselection	Selection by the jury
Applications	211	196	94	48	15
Countries (ERA)	23	22	18	14	6
Austria	4	4	3	3	
Belgium	27	27	14	6	2
Bulgaria	3	2			
Croatia	2	2	2	2	
Cyprus	2	2	2		
Denmark	5	5	1	1	
France	5	3	3		
Germany	11	11	7	5	2
Greece	2	2			
Hungary	2	2			
Italy	42	37	18	11	5
Lithuania	2	2			
Netherlands	4	4	2	1	
Poland	1	1			
Portugal	9	9	3	2	
Romania	1	1	1		
Serbia	4	4	1	1	
Slovenia	2	2	1	1	
Spain	65	63	29	10	4
Sweden	3	3	1	1	1
Switzerland	4	4	2	1	
Turkey	1	1	1		
United Kingdom	5	5	3	3	1
Bosnia-Herzegovina	1				
India	1				
Moldova	1				
Nepal	1				
Russia	1				

2. First selection round: contribution to grand challenges and inclusion of stakeholders (196 > 94)

The first selection round took place between January 11 and January 15, 2016. It focused on the extent to which the project contributed to a societal challenge and the extent to which the project included stakeholders and provided them with feedback during the project. In this assessment five reviewers were involved and each project was assessed by two reviewers (randomly assigned). These reviewers were part of the scientific coordination team of the Delft University of Technology. The reviewers assessed the projects using three indicators:

A – General contribution to grand challenges

B – Extent of stakeholder inclusion, diversity to anticipate and extent of transparency in communication

C – Extent of action taken to provide feedback and follow-up to stakeholders

The scoring was based on a three point scale: 0–1–3; with '3' as the highest score (rather than 2) to obtain a larger variance and more resolution.

As regards indicator A, the reviewers assessed to what extent the applications explicitly articulated their contribution to a societal challenge as formulated by the EU.

For indicator B, the reviewers assessed the diversity of stakeholders that were included in the project. If only other researchers were included, the reviewers scored the projects lower as compared to when a broader set of societal stakeholders were included. The diversity of the stakeholders was assessed in light of what could be expected from the objective of the project; a lower score was assigned on indicator B in case of a mismatch between the objective and the type of stakeholders involved.

For indicator C, the reviewers assessed the extent to which the project used the stakeholders' input to inform the project. If stakeholders were included only for dissemination of results, these projects received a lower score than projects that included stakeholders' opinions and/or values with regard to the project after consultation or deliberation. An even higher score was given if stakeholders were actively involved in conducting the research within the project.

The scores of all reviewers were aggregated, after checking for inclusion of all projects and internal consistency of the scoring. Projects that received widely diverging scores from the reviewers were discussed among the reviewers. This resulted in a selection of 94 projects.

3. Second selection round: analysis of the RRI dimensions (94 > 48)

The second round was carried out between January 19 and 22. In total 94 projects were assessed by five reviewers from the scientific coordination team. The aim was to reduce the set to 40-50 projects to be evaluated by the jury. Projects were distributed randomly among the reviewers, under the condition that as far as possible the reviewers assessed projects that they did not assess in the first round. Each project was assessed by three reviewers, who read in detail the full project description and the answers to the six specific questions. The focus of this assessment was on four dimensions of RRI:

1. Diversity and inclusion

2. Anticipation and reflection

3. Responsiveness and adaptive change

4. Openness and transparency

1. For the dimension of **diversity and inclusion** the following qualitative measurement items were used:

    0: if only other researchers, end-users or direct suppliers or partners of the innovation were included to disseminate the findings at the end of the research.

1: if other researchers, end-users or direct suppliers/partners of the innovation were included during various stages and the reason for including them was because of the different viewpoints, and if it is also explained why and how the applicants included these stakeholders. And/or if a wider group of stakeholders who are only indirectly affected by the innovation were included, but only to inform them about the development of the project.

3: if, in addition to the above, a wider circle of indirect stakeholder groups was included not only to inform, but to also to obtain and include their knowledge and/or viewpoints in a more systematic way throughout the duration of the project. And if the applicants clearly explained how, why and when stakeholders were included and if they give insight how they manage over- and under-inclusion.

2. The second dimension is that of **anticipation and reflection,** for which the reviewers used the following qualitative measurement items:

   0: if only other researchers and research projects were consulted at the beginning to signal new and future trends.

   1: if a wider set of values (technical, social, ethical, legal etc.) was used in a systematic approach from the beginning to include various viewpoints.

   3: if a systematic approach was used to incorporate a wider set of values *throughout* the development of the project and if the applicants explained whether and how they analysed alternative options/ scenarios and clearly articulate how they reflected upon these.

3. For the dimension **responsiveness and adaptive change,** the following scale and items were used:

   0: if they inform the direct stakeholders at the end and explain the effect of the research findings to these stakeholder groups.

   1: if they have a more systematic approach to include stakeholder viewpoints and had a learning approach to include and adapt the research programme according to the findings learned.

   3: if the applicants clearly stated how they recognise new insights and included these during the project in a continuous and systematic way and have incorporated these in logical mechanisms in the design of the project.

4. **Openness and transparency,** was the last dimension against which the projects were evaluated. This dimension was operationalised using the following items:

   0: if only the findings were disseminated at the end of the project, for instance through scientific papers or a conference.

   1: if the applicants are communicating about their project and the results throughout the lifetime of the project. And or if the applicants give notice that they struggle with issues regarding confidentiality and they constantly try to be open as far as possible.

   3: if, in addition to the above, the applicants have a clear approach and logic to the communication and dissemination of the knowledge and results of the research to a wider audience and have articulated the risks if information was not disclosed well enough.

After analysing each project carefully, an internal consistency check was done on the assessment of the projects by each reviewer. The projects with relatively divergent scores among the reviewers were flagged and discussed by all the reviewers. A list ranking all projects resulted from the internal consistency check and this list was compared to the project ranking from the

first round to see if any large differences were found. Since the reviewers applied a threshold of about fifty projects to be considered for the jury assessment, the focus on different rankings was on those projects that were either excluded or included from the first 55 ranking positions. Position 55 was deliberately chosen not to exclude the projects that were just beyond the threshold. This analysis showed six projects that were dropped in the second selection step as compared to the first selection step. All reviewers analysed these projects again and two projects received a higher position. A careful examination of the scoring of each project was then carried out for the positions around position 50 and the reviewers identified a strong difference in scoring between the projects ranking at position 48 and position 49. For the projects after position 49 the scoring was more similar which led the reviewers to decide to stay with the projects up to position 48 to be considered by the jury.

4. Assessment of the pre-selected projects by the jury (48 > 15)

On March 4, 2016, the jury gathered in Brussels at the King Baudouin Foundation to appoint the fifteen finalists. The jury of the EFARRI award was chaired by Prof. Jeroen van den Hoven and composed of the following members:

- Prof. Jacqueline Broerse, Director Athena Institute, VU University Amsterdam, Amsterdam, the Netherlands

- Dr. Klaus Jacob, Research Director, Freie Universität Berlin, Berlin, Germany

- Prof. Richard Owen, University of Exeter Business School, Department of Science and Innovation Governance, Exeter, United Kingdom

- Prof. May Thorseth, Norwegian University of Science and Technology, NTNU, Trondheim, Norway

- Dr. Adriana Valente, Research Director, The National Research Council, Institute of Researches on Population and Social Policies, Rome, Italy

Prior to the meeting in Brussels, each jury member had access to about thirty projects through an online platform and the jury members were asked to assess the projects using the operationalisation of the RRI dimension as explained in step 3. Each project was evaluated by three jury members. Based on the scores from the jury members, an initial ranking was composed. The discussion started with this ranking. First the jury carefully examined the scoring of all projects by the jury members. Careful analysis identified that there was a strong difference in scoring between project ranking position 24 and project ranking position 25, so the jury decided that all experts would discuss at the meeting and evaluate in depth all the projects up to position 24. The remaining projects were quickly reviewed for outliers. This resulted in one project which was also to be considered, thereby placing the threshold at position 25. Following the setting of the threshold, each project was carefully examined and the scoring was discussed between all jury members. Consensus on the first three highest scoring projects was easily reached. This was followed by an in-depth discussion of all the projects up to position 25. For each project the divergence of scores among jury members was discussed. The jury members that did not assess the specific project prior to the meeting were asked to give their opinions as well. As a result, each project was reviewed again and received scores from all jury members. The list that emerged during the discussion was compared to the initial list and all jury members agreed on the position of each project. The difference between the scores of the project ranking at position 15 and 16 was relatively large, which made the jury decide to select the first fifteen projects as finalists.

Step 5. Case study analysis of the EFARRI nominees

Case study analysis of the fifteen shortlisted projects started in May 2016. In preparation for the interviews, the scientific committee did some additional investigations about each project (websites, reports, publications). An interview protocol was developed that included interview topics covering the indicators of RRI. In addition to these, the interview focused on, firstly, the complexity of the social issues related to the grand challenge and how the researchers dealt with potential conflicts between stakeholders and their values arising from this complexity. Second, the interview was aimed at identifying concrete evidence of RRI practices in the research projects. Based on the information in the application form and the additional investigation on each project, the interview questions were adapted to ensure that white spots in the data were filled. Each finalist was contacted by the scientific committee and informed about the objectives of the visits. Every finalist was interviewed by two members of the scientific team. Most finalists were represented in the interviews by a number of researchers involved in the project. For some projects representatives and stakeholders were also present at the interview. The case studies were written making use of data from the interview, the application form and the additional investigations. Additional information was requested from each finalist about the dissemination activities. The scientific committee conducted an Internet search to identify some references that were made to each project in news media. The case studies were sent to the finalists for verification.

Step 6. Selection of the award winners

Based on the reports of the case studies and additional information including CVs of the research team members, publication list, dissemination list of the research activities and some fragments from Internet pages, the members of the jury deliberated together on the selection of the three projects that incorporate the aspects of RRI best.

Step 7. Award Ceremony

On Wednesday October 19th the jury gathered in the premises of the Wellcome Trust in London. During the final event of the EC funded RRI Tools project on November 21st and 22nd 2016 in Brussels, the fifteen nominees for the awards are invited and will present their work to the audience. The jury will announce the three winners of the awards and the audience will vote for the project that stands out with regard to inspirational and effective implementation of RRI.

Step 8. Publication and dissemination

The main findings and results from the case studies and the winning project teams are shown in this report. The report is being published and disseminated among various public administrations, foundations, research groups and research organisations and will serve as a source of new and inspiring practices for other researchers as well as enriching the RRI Toolkit. Since this is the first time the European Foundations Award for Responsible Research & Innovation has been organised, this publication will also be instructive for future applicants.

3. Applications analysis

In total 196 eligible submissions to the award competition were received. The diversity of the applications is very large, in terms of the types of projects submitted, EU countries from which the projects originated and the scientific or academic disciplines in which the projects were carried out. Almost every country within the EU was represented with at least one application.

The objective of the application analysis was to identify the variance of RRI uptake across research disciplines, to assess how RRI is taken up in general, whether it is more represented in some countries or disciplines, its influences upon the research policy agendas of the individual institutions behind the submissions, and to see if recommendations can be developed for possible future calls for an award for RRI.

The methodology applied in the application analysis followed the methodology discussed in chapter 2. Based on a Systematic Literature Review (SLR) a list of criteria was developed to assess the extent to which projects followed an RRI philosophy. The outcomes of the SLR were discussed at an expert workshop meeting, with representatives from across EU member states. The indicators are built on the work of Stilgoe et al. (2013) who have identified four dimensions. We distinguished three categories. We combined them into:

A – General contribution to grand challenges (score 0-1-3)

B – Extent of systematic inclusion of stakeholders/diversity (score 0-1-3)

C – Extent of systematic action taken to provide feedback to stakeholders (score 0–1–3)

This allowed to have qualitative text analyses carried out by five researchers, with each project being analysed by two persons (the two researchers' analyses were combined to give a scale size between 0 and 6 for all projects).

3.1. Descriptives

The projects in the sample of 196 were analysed for the distribution across Europe (Table 2). The distribution shows that the applications are from 23 European countries and one is from Malaysia, but was submitted by a EU-based research institution. Among these countries, Spain and Italy are over-represented with a total of 99 projects, representing more than half of all applications. Belgium is also well represented with 27 applications. From most countries we received fewer than five applications.

Table 2. Distribution of applications across Europe

Country	Number	%
Spain	63	32.1
Italy	37	18.9
Belgium	27	13.8
Germany	11	5.6
Portugal	9	4.6
Denmark	5	2.6
United Kingdom	5	2.6
Austria	4	2.0
Serbia	4	2.0
Switzerland	4	2.0
Netherlands	4	2.0
France	3	1.5
Sweden	3	1.5
Bulgaria	2	1.0
Croatia	2	1.0
Cyprus	2	1.0
Greece	2	1.0
Hungary	2	1.0
Lithuania	2	1.0
Slovenia	2	1.0
Poland	1	0.5
Romania	1	0.5
Turkey	1	0.5

After scoring of the individual projects, each by two reviewers, the average scores for the three criteria could be calculated:

A – The general contribution of the project to address a grand challenge. Similar to the explanation in chapter 2, the projects were investigated to assess the extent to which they address research problems with large social complexity and a clearly present need to engage stakeholders.

B – Inclusion was assessed by the extent to which the project team engaged in informing and including stakeholders from various backgrounds in the project in a systematic way, e.g. from the beginning and throughout the project.

C – Responsiveness was calculated by the extent to which the project team systematically took action to provide feedback to stakeholders and the diversity of means used to do so.

The average scores and standard deviations are presented in Table 3. The scale of the indicators can range between 0 and 6, this because of the two reviewers for each project. For the contribution to addressing a grand challenge, the total sample scores 2.7 on average, with a relatively high score distribution on the 0-6 scale, indicated by the standard deviation (SD = 1.6). This means that most of the projects fall within the range of 1.2 and 4.3, and only a relatively small number of projects has a very high score. Focusing on the aspect of inclusion we see a similar pattern: the average score for the projects is 2.8 (SD = 1.8). For the responsiveness aspect there are even fewer high-scoring projects, with a mean of 1.7 and a SD of 1.5. These findings show that the scales used for the three criteria result in a relatively good variation among all projects and only a few stand out with very high scores.

For the purpose of analysing the projects for the award, this variance is helpful to develop good cut-off or threshold values for considering projects to proceed to the next stage of selection.

Table 3. Scores on the main assessment criteria

	Number	Average score	Standard Deviation
Grand Challenge	196	2.7	1.6
Inclusion	196	2.8	1.8
Responsiveness	196	1.7	1.5

3.2. Grand challenges and RRI across research disciplines

The application forms were also grouped by research discipline. The research team carefully reviewed the application forms and categorised each in one of the following categories:

- **Humanities:** Social, history, philosophy

- **Health:** Medical, care, living

- **Biotech:** Biochemistry, agriculture, bio-based

- **Physics:** natural sciences

- **Urban:** geographical, building environment

- **Economics:** economy, management, policy

- **RRI:** focus on the concept of RRI

- **IT:** software, data-management

Table 4 presents the distribution of projects across the disciplines, with an indication of their contribution to the grand challenges, and the RRI practices of inclusion and responsiveness to stakeholders. Most applications were from the disciplines of humanities and health (each represented by 57 applications). IT as a discipline was represented by only a few applications (five).

The projects from the discipline of RRI research (score = 3.6) followed by the research from biotechnology (score = 3.3) explained their contribution to RRI well, according to the researchers who investigated the submissions. Although the health discipline does focus on the wellbeing of society, the score was moderate (score = 3.0), indicating that their explanations did not reveal complex elements of social value trade-offs that needed to be solved. With regard to inclusion, the data identified that the projects on RRI did well in engaging and including stakeholders (score = 4.1). Remarkably, the projects in the IT discipline did explain their stakeholder engagement and inclusion relatively well (average score = 3.6), while their explanations on the contribution to grand challenges scored moderately well. Also for responsiveness, the projects in the IT discipline scored highest (average score = 3.0), while many other disciplines scored no higher than 1.6, making the total average score for responsiveness relatively low (score for the grand total = 1.7)

Table 4. Extent of RRI across research disciplines

Discipline	Number	Average for Grand Challenge	Average for Inclusion	Average for Responsiveness
Humanities	57	2.4	2.6	1.6
Health	57	3.0	2.7	1.6
Biotech	20	3.3	2.6	1.6
Physics	20	2.8	2.6	1.4
Urban	19	2.6	3.4	2.2
Economics	11	2.2	2.7	2.2
RRI	7	3.6	4.1	2.1
IT	5	2.6	3.6	3.0
Total	**196**	**2.7**	**2.8**	**1.7**

3.3. Grand challenges and RRI across research types

The submissions that we received through the application forms did also differ in the nature and objectives of the projects. A careful examination of the projects resulted in three types of projects. These were:

1. Stakeholder engagement projects, with a focus on public communication and establishing links between science and other societal communities.

2. Scientific research projects, with a clear focus on developing improved research outcomes in terms of quality and/or applicability.

3. Methodology projects which aim to develop better methodologies or instruments for a specific research discipline.

Although only three groups were identified, the mean scores for each one on the contribution to grand challenges and the practices of RRI, e.g. stakeholder engagement and responsiveness are presented in Table 5. In total 92 applications related to *stakeholder engagement* projects were submitted, 75 applications related to *scientific research* projects and 29 applications related to *methodology* projects.

The scores for the applications on the contribution to a grand challenge did not differ strongly across the three research types. Regarding the engagement and inclusion of stakeholders, the projects do differ significantly. The *stakeholder engagement* projects score highest (average score = 3.3) for this criterion, followed by *methodology* projects (average score = 2.8) and the *scientific research* projects (average score = 2.3). For the responsiveness of the research groups to their stakeholders, Table 5 shows that both *stakeholder engagement* projects and *methodology* projects scored highest with an average score of 2.0, while scientific research projects lag behind with an average score of 1.3. This may indicate that methodology and stakeholder engagement projects articulate more explicitly that they are responsive to societal needs and values, while for scientific research projects such direct influence on the projects was less prominently articulated.

Table 5. Extent of RRI across research type

Research type	Number	Average for Grand Challenge	Average for Inclusion	Average for Responsiveness
Stakeholder engagement projects	92	2.8	3.3	2.0
Scientific research projects	75	2.7	2.3	1.3
Methodology projects	29	2.6	2.8	2.0
Total	**196**	**2.7**	**2.8**	**1.7**

3.4. Conclusion

The analyses of the application forms were done for a sample of 196 project applications. The objective is to better understand how the contribution to a grand challenge and the RRI practices vary across EU countries, research disciplines and research types. The data presented large differences for the number of applications across the European countries.

For the various academic research disciplines, the data show that the Humanities and Health disciplines have the strongest presence but the projects from the Health and Biotech discipline score highest for the grand challenges. It is remarkable that while the projects from both RRI & IT disciplines do not have a very strong presence in terms of the number of submissions, they did score highest on inclusion.

When taking the research type into account, it clearly shows that citizen science projects have a strong presence and score relatively highly for their contributions to one of the grand challenges and the explanation of how they conduct their research in a responsible manner. This may be due to the natural focus of these projects on communication. The projects that focused predominantly on specific research tend to lag behind in the areas of stakeholder inclusion and responsiveness.

4. Case studies of the 15 finalists

4.1. ¡Pasa la voz!

Project	¡Pasa la voz!: spread the word and raise awareness about Chagas disease with and among the stakeholders with the aim of improving access to diagnosis and treatment
Organisation	Fundación Privada Instituto de Salud Global Barcelona (ISGlobal) and Global Chagas Disease Coalition
Research location	Barcelona, Spain
Cooperation partners	International Health Service – "Clínic" Hospital, Barcelona and several Bolivian associations in Barcelona
Team	Five researchers, three field coordinators and one communication manager
Funding sources	Agència Catalana de Cooperació al Desenvolupament (ACCD), Chagas Initiative (ISGlobal), Global Chagas Disease Coalition
Websites	http://www.isglobal.org http://www.coalicionchagas.org/

ORGANISATIONAL BACKGROUND ●●●

The research is being carried out by the ISGlobal team and the coordinator of the Global Chagas Disease Coalition. Five researchers from ISGlobal are involved, one of whom coordinates closely with patients at the International Health Service, Hospital Clinic of Barcelona. A campaign designer is also involved and communicates with the project's stakeholders about the project and related events. She is a Chagas patient herself, who is collaborating with the project in the context of her Master's degree in International Health and Cooperation at Universitat Autonoma de Barcelona. The project team collaborates with the Global Chagas Disease Coalition, which coordinates monitoring, evaluation and replication of the methods in other locations.

The project has established a partnership with several Bolivian and Latin American associations in Barcelona, such as *ARBOLAG (La Garriga), La Bayeta Parlante, Cristo Viene, Bolivianos de Corazón (Granollers)* and the *Comité Ejecutivo Cívico Cruceñista en Cataluña*. This partnership has strengthened the project, allowing the design of collaborative and trust-based access to people who may be living with the parasite.

FUNDING ●●●

Funding is based on three sources: the Agència Catalana de Cooperació al Desenvolupament (ACCD), Chagas Initiative (ISGlobal) and the Global Chagas Disease Coalition.

PROBLEM BEING ADDRESSED ●●●

Chagas Disease is a neglected tropical disease that silently kills thousands each year. In total there are about 6-7 million people living with the parasite, most of whom are poor, both in endemic countries and in places such as Europe. The disease comes from a parasite that lives in houses made of organic material. The parasite can infect many patients without them knowing they are infected. In the early stages, the symptoms of the disease are often not present or may only consist of fever, headaches, or local swelling at the site of the bite. After some eight to twelve weeks the chronic phase begins and about 60-70% of the people infected never have symptoms. For the remaining group, however, the disease can lead to enlarged cardiac ventricles which eventually leads to heart failure. The disease can also have severe digestive complications.

RESEARCH DESIGN AND SOLUTION ●●●

ISGlobal has been involved in research and training related to Chagas disease since 2002 and is currently working on an intervention strategy in Bolivia, the country most affected by this forgotten disease. This strategy involves intervention on three levels: measures aimed at providing direct care to patients in order to improve the full cycle of care (prevention, diagnosis, and treatment); training of public health care professionals in the management of Chagas disease; and the development of research protocols through a joint scientific platform.

The main goal is to improve access to diagnosis and treatment by improving awareness of Chagas Disease (CD) with and among affected populations and health professionals.

The specific objectives are:

- To stimulate demand for CD services by implementing Information, Education and Communication (IEC) activities together with patients;

- To understand barriers to accessing CD health services for Bolivian communities living in Barcelona, Spain, and evaluate the effectiveness of IEC practices, through research with and for the community;

- To develop a guide to outreach activities and an "IEC Kit" to be used by other actors;

- To increase knowledge among the community and among health professionals through the Global Chagas Disease Coalition;

- To support the activities of the patient association in promoting to integrated CD care.

The strategy is to implement a pilot IEC project that will improve access to the International Health Service of the "Clínic" Hospital, in Barcelona, Spain, the European country with the largest population affected by CD. Based on the IEC actions, research is conducted on how to approach and inform people and persuade them to take part in diagnosis and treatment. Women play an important role in reaching out to communities. This partipatory approach is essential to gain access to people and persuade them.

Subsequently, and most significantly, the experience of engaging possible patients is studied and focused on demand for CD health services among migrant families. The findings are then developed and communicated in the form of recommendations on ways of improving IEC practices. These practices are shared with other actors in the Global Chagas Disease Coalition.

GRAND CHALLENGE BEING ADDRESSED ●●●

¡Pasa la Voz! aims to break the cycle of negligence caused by the fact that Chagas Disease can lie dormant for decades. This is often the result of a lack of political willingness, and the profile of affected populations, who are predominantly marginalised and lack a political voice. CD is a hidden public health crisis needing attention. Some 6-7 million people live with the parasite, with a global financial cost exceeding $7 billion annually, while less than 1% of CD infected people receive treatment. We need effective IEC practices to stimulate demand and activate political willingness. Not only is treating patients a matter of basic human rights, it is also a public health responsibility and a cost-effective, wise investment. Treating women during their child-bearing years stops transmission to newborns. Women are key to changing the future of CD, as it is unacceptable for children to be born and live with CD in the modern world.

Evidence-based research shows that treating chronic patients is possible, and there is reported evidence of benefits of treatment among different population groups. Medical evidence, however, is not enough, since many public health professionals and clinical care communities are unaware of the treatment options or reluctant to implement them. Furthermore, people at risk of being infected do not look for information or for comprehensive care. This is mainly because the disease is associated with poor living conditions. Having the infection shows that people are poor or have lived in poor housing conditions, so it will adversely affect their social position. Stigmatisation and fear may also play a role in the lack of active demand. Even if IEC practices are considered as a key part of Integral Care Programs, these often lack the effectiveness to bring about changes. Furthermore, having the disease is not always uncomfortable during the chronic phase, while the treatment requires adapting the way people live their lives and also comes with side-effects, so they do not acknowledge the benefits of treating CD.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

This project incorporates key stakeholders from the beginning until the evaluation stage, ensuring their participation in working groups and encouraging them to make an active contribution. Key stakeholders in the pilot project are migrant populations, patients and patient associations, as well as health professionals. Women are involved as change agents in spreading the word about CD. Through training and distribution of IEC kits, women will lead IEC practices across their communities.

A participatory approach helps to thoroughly investigate social and economic determinants which prevent access to health services. The research follows a detailed approach on how to target audiences, identify groups and communities to communicate with and make detailed lists of who is informed, interviewed and diagnosed and followed up. To motivate people to take part in the diagnosis, social networks are engaged to help to support them through the process. Women are important in supporting and accommodating the process. The researchers take part in social events at churches, Bolivian community and sporting events to communicate about CD and the options for diagnosis and treatment. Another key element of engagement and non-formal science education will be the activities with and for patient´s associations, aiming to empower and accompany them in advocacy and communication activities.

A political willingness to address the disease is crucial. It helps to involve patients more so that they can be diagnosed and treated. Collaboration therefore takes place with stakeholders such as key decision-makers, the scientific community, key actors working on CD and the general public who will be target audiences and/or will disseminate awareness activities. By integrating different stakeholders the team addresses the gender balance, responsibility, ownership and recognition and brings about the added value for the community.

To reach out to wider audiences and the political landscape, the research team draws on the Global Coalition and the pilot activities, led by a coordinator, ensure excellent internal communication: including the working groups, calling for participation and preparing minutes to update all key stakeholders. In the framework of the pilot project, health staff in clinical services both in Spain and Bolivia ensure regular and informed communication with patients. In addition, the team promotes communication among the group of identified women who will be spreading the word in their communities. Finally workshops and training courses also form part of the communication plan.

External communication, in a spirit of open and transparent science, will be led by the Global Coalition and ISGlobal. The website is a hub where CD-related information and resources to develop effective IEC practices will be available for any actor. Dissemination will be furthered by a newsletter and through twitter and Facebook accounts. All relevant information including both an IEC kit and an IEC set of recommendations will be available for download. The methodology, implementation and evaluation of the project are fully accessible to other research teams, associations, or other stakeholders willing to do the same in their own contexts.

EVALUATION AND DISSEMINATION ●●●

The team at IS Global involved in research on CD constitutes a small group within IS Global but is well embedded in the community where the research is taking place. The main coordinator María Jesús Pinazo Delgado is Bolivian and conducted research on similar topics before joining IS Global and this project. The team is well connected to a hospital, has several communication and event organisers and has established a network of coordinators to obtain access to the Bolivian community.

The project team has published three articles and twelve book contributions since 2010 within the area of Medical and epidemiological publications. The articles were published in international journals such as *Acta Tropica* and the *Journal of Gastroenterology and Hepatology*. In the area of Sociological research, four reports and a book contribution were presented. Several of these publications specifically target governments in Spain and Bolivia. The impact on civil society is relatively large, partly due to its focus on communication about CD. Also within the policy landscape, the research is actively disseminating its findings. The project team was recently contacted by Raíses Andinas, a Latin American association which has fifty members and could reach 300 Bolivian citizens living in Zaragoza, Spain. Contact was made through whatsapp videos and they will have access to Chagas disease diagnostics. Public health practitioners in Zaragoza are not as aware of the disease as they are in Barcelona.

4.2. 3DNovations

Project	3DNovations
Organisation	Hao2.eu (pronounced 'how to')
Research location	Surbiton, United Kingdom
Cooperation partners	Various industrial, public sector and education partners; Kingston University & University College Dublin, Autus (foundation for people with autism set up by Hao2.eu) and most recently, i-deas.ie – a social business Hao2.eu has set up in Ireland as part of its EU growth strategy
Team	One founder/director, one R&D tech, one quality/ops – supporting pool of 20 freelancers (80% of the members have autism/disabilities)
Funding sources	Through service delivery and donations
Websites	http://www. hao2.eu http://www.autus.org.uk

ORGANISATIONAL BACKGROUND ●●●

3DNovations is the brand under which the social business Hao2 conducts research, initiates co-designs and commercialises 3D environments, develops platforms and cloud services. These activities enable people with autism and other complex needs to create and access support services, vocational training and work related opportunities that better meet their needs and demands. The functional driver behind this is the 3DNovations platform and 3D Cloud services which represents a 3D digital environment.

The 3D environments are accessed using avatars (similar to gaming technology), to reduce barriers to engagement and participation and enable people with autism and complex needs to have an active role and influence in research design and delivery in a way that would not be possible otherwise. There is a body of academic work that collated the positive effects of using 3D virtual world technology as an assistive technology / learning tool by people with autism and other communication disabilities.

FUNDING ●●●

This company is not the result of an official university research programme, but originated from Herbertson's own initiative starting as an entrepreneur. It was also related to personal experiences with autism (son) and unemployment (self). Some of its income has come from grant-based funding from a variety of different sources but it primarily aims to generate income by charging organisations and partners for its technology services and in doing so creates training and employment opportunities for people with autism both within the company and in the organisations purchasing its services. The fees Hao2.eu receives for its services from these organisations and partners are invested in research and development to cover salaries and operational costs and used to commission services from or make donations to Autus – the Hao2.eu Foundation. Hao2.eu's business objective is to lead the technology industry by example by showing it can be a successful, highly competitive, innovative and sustainable social business that reinvests its profits in improving outcomes for people with autism in the UK, EU, the Commonwealth and China.

PROBLEM BEING ADDRESSED ●●●

People with autism now represent around 1% of the UK population (equal to about 700,000 people, meaning that the lives of around 2.7 million people are touched by autism). Around 70% of autistic people believe that they do not receive enough support or effective support from social services; only 15% of adults with autism in the UK are in full-time paid employment and only 10% of them receive employment support, even though 53% say they want it. In addition, between 44% and 52% of autistic people also have a learning disability. This shows the urgent need to provide better employability and employment services targeting this specific group of citizens. The objectives for the project are threefold:

- To demonstrate the potential of online 3D environments accessed using avatars to enable people with autism and complex needs to lead as well as participate in designing and delivering research and development that can deliver sustainable and scalable social and economic benefits and outcomes.

- To influence social and cultural change by research and developing 3D cloud platforms and services as responsible research and innovation tools that organisations of all kinds can use to make their services more accessible and inclusive for people with diverse needs.

- To improve employability prospects and outcomes for people with complex conditions such as autism by enabling them to access relevant services and training in a way that better meets their needs.

RESEARCH DESIGN AND SOLUTION ●●●

The relevance and potential of the platform was explored through good case studies, including many stakeholders and by providing examples. During the next phase, the focus is on further growth and professionalisation. Very practical barriers to growth are identified, including the readiness of the technology market (people don't know they could have a use for the Hao2 innovation, 3D virtual reality; but also after the economic crisis), and access to finance and support for people who don't have the networks and networking skills, such as people with autism.

Currently there are ten 'hubs' (locations based in various communities) around the country which are helping employees with training on how to use the 3D system and how to train people with autism. These people are able to help people with autism afterwards. The project is still in the start-up phase at present and these external hubs usually receive start-up funding; when the funding ends they continue to operate through volunteer support but with more limited capacity.

GRAND CHALLENGE BEING ADDRESSED ●●●

The societal challenge addressed in this initiative relates to inclusion and social justice: there is a gap between what people with autism have access to vs. what others have access to. Tackling exclusion (e.g. from school, from employment), having a voice, having an influence, having a job and contributing to society is what this project aims to contribute.

Providing support to people with autism can be done at a lower cost, saving money for society, through prevention of current exclusion of people with autism. There is an annual cost of £38 billion annually in the UK that results from 'failing' (as Herbertson puts it) autism citizens who have potential especially when assisted by technology. There is a pool of 600,000 people who may have potential digital skills to fill this gap. There may also potentially be a deficit of skilled workers within the UK in the near future. This tool may help to remedy that. In addition to addressing an existing social need, the research is engaging end-users in the creation and evaluation of services, whilst helping traditional public employment service providers to reach a group that is traditionally very hard to access in a cost-effective way.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The target group and audience of young people with autism and other complex needs is fully and directly involved in the research project. The rationale for including them is that people with autism are best placed to communicate their needs and are completely capable of doing so. The research project itself facilitates their involvement because it uses a technology that they are familiar with already through gaming. This is used to effectively engage them in activities such as training and development in which they would normally not participate and gain their feedback, thoughts and ideas on how to create services that meet their needs better. The substantial use of ICTs taking place outside of the recognised institutional setting is radically modifying the existing mechanisms of service provision, allowing autistic people to gain employability, social skills and engage with other parties in a completely new way. The partnership approach in the delivery of this project has meant that stakeholders such as funders, public services, voluntary sector organisations and employers have been able to engage and communicate their needs directly with the target group using a method that does not intimidate but empowers those for whom the research is intended.

The 3DNovations research project communicates with, absorbs information from and gives feedback to target groups, audiences and stakeholders in real time, openly and transparently, using a range of different approaches in various ways.

- By visiting organisations and participating in face to face meetings, in a one to one setting, in small groups as well as larger events and conferences.

- Through e-mail, written documents and publications, blogs, Twitter, Facebook, YouTube and images posted on the web, both on their own website and on partner websites.

- Via services definitions and service information provided on the UK HM Government Digital Marketplace.

3DNovations uses open-source technologies such as Opensimulator and aims to offer its services free of charge to citizens with autism and/or complex needs who need its services and cannot afford to pay for them. Hao2.eu charges organisations and partners for the 3DNovations services it provides because these services help them to innovate and improve services, particularly for people with autism and disabilities, and save them money and operational costs. If organisations or partners are unable to afford 3DNovations services, they can gain access to 3DNovations through 3DNovations hubs or through collaborative projects with Autus – the Hao2. eu Foundation. The research behind the initiative has been user-led from the outset. Their input/ insight has ensured that it adopts an action learning approach. Those who benefit include not only people with autism themselves, but also those who take care of them and the society in general, through improved use of the work force.

EVALUATION AND DISSEMINATION ●●●

The core research team is relatively small but draws on an extensive network of freelancers and contacts in industry and academia. This is in part because of the focus on not simply emphasising research, but also doing something in practice. Any reports available are consequently not in the academic, peer-reviewed category. Still, the initiative does get reported on frequently in (inter)national media. The research team has a strong presence in a variety of media facing diverse audiences. About 600 people have been helped so far; probably about 1/3 of those people have autism. The other people are trainers, parents and coaches. There are examples of unemployed people with autism who have university degrees and after using Hao2 got a job. Other people without qualifications (for example who had no degree because of difficulties at school), who got training, felt better about their potential on the job market, and then got a job. There are examples of people who have been involved in the programme for a very long time (with considerable educational needs) and others who are only in the programme for a very short time (only a few types of courses).

4.3. Belgian Ageing Studies

Project	Belgian Ageing Studies (BAS)
Organisation	Belgian Ageing Studies Group at the Vrije Universiteit Brussel and Hogeschool Gent
Research location	Brussels, Belgium
Cooperation partners	Various local and national authorities and healthcare institutions across 170 municipalities in the Flanders region
Team	Three professors, two postdocs, five Ph.D candidates and students
Funding sources	Vrije Universiteit Brussel and national research grants
Website	http://www.belgianageingstudies.be/

ORGANISATIONAL BACKGROUND ●●●

The Belgian Ageing Studies (BAS) project is developed and conducted by researchers at Vrije Universiteit Brussel and Hogeschool Gent in collaboration with the provincial government of West Flanders, local authorities and members of local senior organisations. It is a participatory research programme designed with and for older people to create opportunities for active ageing in Belgium. The main aim is to support the process of creating evidence-based, age-friendly communities through involving older people in policymaking decisions. The project started in 2004 and currently involves 170 municipalities in Flanders. Within these municipalities are advisory boards consisting of older people's organisations and local stakeholders; there are around 8,000 older volunteers and more than 80,000 participants aged over sixty.

FUNDING ●●●

Within the group there are three people who are funded by the university (three professors) and other staff are paid through external funding. The group also regularly attracts national and international university research grants. They have explicitly not sought to be paid by the organisations in which they carry out their research, such as municipalities, to maintain their status as neutral researchers without a political agenda. This has been done despite various requests from municipalities to host a project in that specific municipality.

PROBLEM BEING ADDRESSED ●●●

The research team tries to support vulnerable groups within society, particularly older people, to give them more influence over policy. The societal relevance that the BAS project aims to achieve comprises:

- support for the process of age-friendly policy-making at the local level;

- broadening of ageing issues to include social and political aspects rather than merely medical issues;

- potential for involving older people in research and policy-making;

- creation of social networks of local stakeholders;

- offering local authorities explanations and possible intervention strategies to tackle aspects of disadvantage and exclusion within the older population.

The team provides a survey tool to measure living conditions and aspects relating to the quality of life of older people at the local level, such as housing conditions, care, social networks, neighbourhood aspects, volunteer/social/cultural/political participation, frailty, physical and mental health and social exclusion. The team engages older people as central actors (peer-research) in their research and promotes evidence-based policy at the community level by providing input and mobilising knowledge for planning and inclusive policy programs. Currently, such fragile groups are often excluded. The main purposes of the BAS project are:

- To provide a survey instrument to measure the living conditions and aspects of quality of life of older people at the community level, including a wide range of aspects such as housing conditions, feelings of loneliness, care, social networks, neighbourhood aspects, volunteer/social/cultural/political participation, frailty, physical and mental health, feelings of being unsafe, social exclusion;

- To engage older people as central actors in research and policy planning;

- To promote evidence-based policy at the local level by providing input and mobilising knowledge for planning and inclusive policy programmes;

- To provide and enable open access for municipalities, local and regional authorities, societal stakeholders, and older adults to access the data and publications;

- To create opportunities for active ageing at the local level, and to support the process of creating age-friendly communities;

- To examine trends in specific municipalities by conducting follow-up studies;

- To create engagement among all societal actors by means of a community network.

An example: In 2007 one municipality implemented the BAS research project. At the end of the project that municipality received figures covering a wide range of aspects such as housing conditions, feelings of loneliness, care, social networks, neighbourhood aspects, physical and mental health and feelings of being unsafe. An important finding was that a substantial number of older adults were facing feelings of loneliness and the municipality developed a neighbourhood project to tackle this by means of volunteers. These volunteers help older people with minor issues and assist them by providing information in areas where regular caregivers do not provide support. In 2014, the interventions were evaluated and the number of people facing feelings of loneliness had reduced significantly. In response, the municipality organised a post for a 'mobile civil servant', who visits old people in their homes.

RESEARCH DESIGN AND SOLUTION ●●●

The project has been developed in collaboration with the Flemish Provinces, 170 municipalities, advisory boards comprising older people and other local stakeholders. In total over 8,000 older volunteers have been recruited and more than 75,000 older people are participating in the studies in Belgium. The innovativeness of the Belgian Ageing Studies lies mainly in its participatory research methodology. Older adults are not merely seen as the target group for the

study, but also as active participants and actors in developing the research, carrying out the study, evaluating the project, and developing policy plans based on the study findings. This is a specific method of 'peer-research' developed by the group. This method involves older people not only as research participants, but also as essential partners in the research project. A central aspect of the project involves the training of these older volunteers, as well as the process of monitoring by a supervisor, who is also an older volunteer. These volunteers are engaged in the project from beginning to end, including feedback on the results of the study.

In a joint creative process involving older people, civil society organisations, senior advisory boards, local authorities and other stakeholders, a research system was developed which created the potential to facilitate innovation and social change in municipalities and policies on ageing. In the late 1980s, the team first created this approach and it has been further developed over the past decades. The method is published in SAGE Methodology. The main principle is based on two steps. First, the target group is analysed and investigated to identify the issues they are facing. Intervention then takes place through providing solutions and bringing the issues onto the agenda of policymakers. The second step takes place after a couple of years; the actions and interventions are evaluated and reported back to the local municipalities.

GRAND CHALLENGE BEING ADDRESSED ●●●

The group considers it important to include fragile groups, in this case the elderly people, in policymaking, particularly in regard to policies that concern these groups themselves. They also wish to further deepen the understanding of informal learning as a concept. As such, the grand challenge seems to revolve largely around creating inclusive and reflective societies in light of ageing populations.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The project supports a shift away from the view that older people are merely passive consumers towards a view of older people as active participants and actors in society; diverse groups of older people are involved in the study (most vulnerable older adults and the oldest old) who are often the most under-represented in ageing studies and the BAS project has stimulated local authorities to put a number of aging-related themes on the local policy agenda. The research team emphasises that only things that have societal relevance need to be done, and they even refuse payments from the target groups concerned or politicians. Their rationale is: 'we can write a project proposal, wait a year, recruit a Ph.D student and then start, or we can just start directly with our own resources, within the group'. Their experience is that when financing from the (local) government is offered, demands relating to the content are also added to the research request. They do not want this, so generally reject funding that is offered for requested research.

The engagement of stakeholders is based on the recruitment of volunteers. This is done directly by using some form of snowball sampling (a friend knows a friend) or calls for volunteers through newspaper publications. Information acquired from the studies is presented to all actors involved: volunteers, municipalities, provinces, members of local parliaments, mayors, etc. The researchers try to interact with these stakeholders as closely as possible. The volunteers appreciate their close contacts with the research team, particularly since it gives them a voice and allows them to talk to the professors. Sometimes issues are identified that raise problems and the team has to deal with these. Such issues are occasionally taken out of context by journalists, who present these aspects as more important in the media, even though the issue had not been the focus of the report.

The municipalities (or provinces) that participate receive the raw data. The reports are free and the scientific findings are published in peer-reviewed journals that are not open, and also in public media (sometimes there is money in a project for open access publishing). Even though their peer-research concept is published, the team is somewhat protective when other groups want to use their validated method. Other researchers can use it, but under contract from this research team, because the team wants to guarantee the quality of their methods.

The Belgian Ageing Studies have five important target groups and audiences: older people, professionals working with and for older people, policymakers, researchers and the wider audience. These people are reached through six important channels: press releases, local presentations in each participating municipality, articles in journals (national and international), books, seminars (national and regional), website (in Dutch, French and English). At specific time points during the research project, the municipality gives press releases to communicate to the wider audience (approximately three or four press releases in each municipality). At the end, the results of the study are presented to participants, older people and stakeholders in each municipality. Every participating municipality can also access – in addition to the presentation and open access data, a report that explains the implications of the results. BAS also communicates the results of the studies to a national and international audience.

The scientific importance of the BAS project and its societal relevance are closely intertwined, as the study was initially developed to support the process of developing age-friendly policies at the municipality level. Rich data collection and the scale of the data set are opening up a wide range of opportunities to gain deeper insights into a number of aspects which are relevant in an ageing society. It also offers opportunities for comparing municipalities against specific benchmarks, such as averages for Flanders, the province, comparable municipalities and cities. Prominent differences between municipalities in regard to particular findings also call for further in-depth research in order to understand local dynamics and contextual factors influencing these particular outcomes.

EVALUATION AND DISSEMINATION ●●●

The research team is relatively small and works independently of the municipalities. The research shows a feasible approach to including fragile groups in policymaking and making policies that are also supported by society. A number of foundations, support groups and interest groups have originated from their activities. The research team has many years of experience and has generated many publications and approximately ten Ph.D theses. Publications include e.g. eleven scientific monographs in national publications, five contributions to scientific monographs with international referee system, 34 articles in scientific journals with international referee system in journals such as *Journal of Applied Gerontology, European Journal on Criminal Policy and Research, Procedia – Social and Behavioral Sciences and Journal of Aging and Physical Activity,* eleven articles in monographs with national referee system, eighteen articles in journals with national referee system and eight reports of research projects submitted to the subsidising organisation after conclusion of the activities.

4.4. Co-creation of knowledge for sustainable urban development

Project	Co-creation of knowledge for sustainable urban development aiming at fair, green and accessible cities
Organisation	Mistra Urban Futures
Research location	Gothenburg, Sweden
Cooperation partners	See the description of the seven partners under Organisational Background
Team	Multiple researchers are involved from the various consortium partners, depending on the objectives of specific projects
Funding sources	MISTRA (Swedish Foundation for Strategic Environmental Research) and consortium members
Website	www.mistraurbanfutures.org

ORGANISATIONAL BACKGROUND ●●●

Mistra Urban Futures is an international centre for sustainable urban development. Mistra Urban Futures was established in 2010 as a 10-year research programme and research centre to address issues on sustainable urban development with a trans-disciplinary approach using co-creation and co-production of knowledge with stakeholders, advocacy groups and citizens, as the basis for all activities. The purpose is to contribute towards making a real difference to the environment and to people's lives in the cities of the world. Practitioners and researchers cooperate closely to produce excellent and relevant knowledge. The centre offers an arena for development and engagement as well as for dissemination of knowledge, in which cooperation with business, interest groups and the general public is developed. Over fifty projects have been carried out at the centre, involving over 600 people. Each project is organised in dual project management with one academic and one practitioner. The team leader is the director of Mistra Urban Futures, Professor David Simon, who is the director of the research centre and research programme, and Mr Mikael Cullberg, who is the director of the Gothenburg platform. The application is based on six selected projects:

1. Urban Station Communities, partnering with Royal Institute of Technology, Göteborg Region Association of Local Authorities, and Trafikverket;

2. WISE – Well-being in Sustainable Cities, partnering with Chalmers University of Technology, and Region Västra Götaland;

3. KAIROS – Knowledge about and Approaches to Fair and Socially Sustainable Cities, partnering with University of Gothenburg – Dept. of Global Studies, City of Gothenburg, and Northeast;

4. Divided City, partnering with Royal Institute of Technology, Chalmers University of Technology, and City of Gothenburg;

5. Embedded Research of the River City Vision, partnering with University of Gothenburg, and Gothenburg Research Institute;

6. Urban Food, partnering with UPRISE/Urban and Sustainable Futures, University of Salford.

Projects are performed within the Gothenburg Consortium, which is a result of the Mistra call in 2009. A total of seven main partners have the role of founder and funder of the consortium. These are Chalmers University of Technology (host of the consortium), University of Gothenburg, City of Gothenburg (Public authority), Region Västra Götaland (Regional parliament), Gothenburg Region Association of Local Authorities (Association of local municipalities surrounding Gothenburg), County Administrative Board of Västra Götaland (National government authority with regional jurisdiction), and IVL Swedish Environmental Research Institute (National research institute in the sustainable society and building sector).

Following the "local interaction platforms" in Gothenburg, similar platforms are being formed in Greater Manchester (UK), Kisumu (Kenya), and Cape Town (South Africa).

FUNDING ●●●

The Consortium partner submitted a proposal as a response to the call from Mistra in 2009. The programme is funded jointly by Mistra, the Swedish Foundation for Strategic Environmental Research, and a Gothenburg consortium of two universities, four public bodies including the City of Gothenburg and the region, and an environmental research organisation. Since that time all partners have contributed financially to the Mistra funding on a "matched" basis which includes both cash and funding in kind in the form of time for employees and officials to actively take part in and work on the projects.

PROBLEM BEING ADDRESSED ●●●

Cities are among the most complex systems on the planet. They involve social structures, laws, people, ecosystems, built environments and cultures. They are ever-changing and firmly rooted in their local context. New cities are emerging and many existing cities are becoming larger as the world is undergoing increasing urbanisation. The majority of the world's population lives in urban areas and according to the UN 66 % of the world's population are predicted to be living in urban areas by 2050. This means that more city space is needed in the next thirty years which requires adaptations to address complex social challenges. Cities should be convenient and easy to live in but not adversely affect the environment, economically prosperous without social exclusion. Cities have the potential to answer future human needs. The benefits of living together are substantial. It's in cities you'll find the greatest opportunities to optimise resources and make them available for all.

RESEARCH DESIGN AND SOLUTION ●●●

Mistra Urban Futures gathers actors from research and practice to work together to co-create and co-produce knowledge. This sharing of knowledge, understanding and expertise from both fields is needed to enable sustainable futures. Since many different competences are also needed, academic and professional experts from a range of fields, from business to sociology, political science, architecture, biology, physical resource theory, law, human ecology, engineering sciences and design, are involved in different research projects.The research approach that Mistra Urban Futures follows can be described in three stages. The first step is to identify challenges and questions that need to be met and to mobilise resources. The second step is to generate knowledge and understanding through different research projects. The third step is to enable implementation of the results, working towards sustainable urban development.

Mistra Urban Futures has so far initiated some seventy different projects, more than fifty of which are linked to the Gothenburg platform. The various target groups, audiences and stakeholders were included in the projects from the very beginning through the creation of the "Gothenburg Consortium". The consortium has appointed an engagement officer who provides support on a regular basis for the involvement of different stakeholder groups in the various projects. This involvement is based on a firm belief that the challenges of urbanisation, global climate change and sustainability can only be met through collaboration and joint action. This inevitably leads to other challenges, such as integrating varying frames of reference and modes of operation.

Transdisciplinary research and knowledge production include acknowledging the values of all kinds of knowledge – not only academic knowledge. Consequently this also includes a responsibility to communicate in a transparent and participative way.

GRAND CHALLENGE BEING ADDRESSED ●●●

Urbanisation, global climate change and sustainability are major societal challenges and they cannot be solved through technological breakthroughs alone. On the contrary, there is a general understanding that these challenges can only be met through collaboration and co-production of knowledge, working across disciplines and societal sectors.

Mistra Urban Futures was formed to contribute to this development, particularly focusing on the issues concerning sustainable urban development. A consortium of partners, including researchers, practitioners and policy-makers have committed themselves to develop and work in trans-disciplinary and collaborative ways, with all stakeholders including citizens involved, to find academically excellent and practically relevant solutions to the challenges that exist.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

Mistra Urban Futures uses general communication tools, such as a website, reports, books and book chapters, policy briefs and articles – each with their respective target groups. Social media plays an increasingly important role, not least with the opportunities social media offer for feedback and true two-way communication. The international review panel paid particular attention to this, and recommended adding an "engagement manager" to be appointed, not only to develop communication and dissemination, but also to contribute to the design of projects to allow as much dialogue and as many participative features as possible.

The mid-term Review carried out in 2015 by an international review panel acknowledged the positive development of Mistra Urban Futures, including first and foremost the co-creation and co-production of knowledge approaches and subsequent results. The panel recommended that this approach should be further strengthened, including a recommendation to add further "engagement" knowledge and experience to the staff (see above). Furthermore, four "outcome studies" were carried out by the various platforms. All of these referred to the positive responses from policymakers and "practitioners" and city officials regarding the collaborative activities and the value of adding a research dimension to the policy and strategy work of a city.

The Strategic Plan for 2016-2019 and the Centre Operational Plan for 2016 reflect the conclusions of the mid-term Review and the subsequent funding decisions made by Mistra and the Gothenburg Consortium. This particularly includes the ongoing development of collaborative and comparative research, i.e. the "bottom-up" concept of local research results and issues being fed upwards and compared with other cities in similar or different contexts.

On 19-20 September 2016, Mistra Urban Futures organised its first 'Annual Conference' on the overall theme of 'Realising Just Cities', sub-titled 'Co-Production in Action'. This is meant to be the first in a series of annual conferences covering the development of transdisciplinary research and knowledge production for sustainable urban development. The conference explores a number of issues concerning 'just cities', primarily around contextualising the challenges of the just city and the need for social sustainability, which is only achievable through participation and co-creation, including in the initiation and implementation of research and its results.

The conference continues with workshops for those who want to engage further with the Centre and its projects, thus developing the 'core processes' of urban change, urban knowledge and urban governance that constitute a basis for sustainable urban development, with the aim of creating accessible, green and fair cities. Finally, from 2016, all publications by researchers and other authors of Mistra Urban Futures are Open Access as far as possible; exceptions are only made for previously agreed publications, books and similar. A separate budget has been allocated to cover OA fees, including books that can be downloaded for free.

Key words characterising 'just city' conference

EVALUATION AND DISSEMINATION ●●●

The research group at Mistra Urban Futures is well developed and has a relatively strong presence in academia and practice. The researchers are well recognised and have wide-ranging contacts. The team organises many events on a regular basis and for example holds two conferences (200-400 attendees) each year. The research model can be replicated anywhere where the combination of local stakeholders' initiatives and interests co-exist with an open and inclusive academic environment. This is shown through the replication of the model in other regions, e.g. Manchester, Cape Town in South Africa and Kisumu in Kenya. The research team has presented a wide range of publications aimed at the scientific community and a wider group of stakeholders in cities, governments, regions, public authorities, industry and NGO's. In total 71 journal publications and conference proceedings were included dating from 2010 or later and published in varies journals such as *International journal of Marketing Studies, Social Dynamics: A journal of African Studies and Journal of Arts and Humanities.* Furthermore, twenty books and book chapters were mentioned, as well as a selection of 32 reports published since 2013.

4.5. EnAHRgie

Project	RRI and Renewable Energy – Conception of sustainable land use and energy supply at the municipal level (EnAHRgie)
Organisation	EA European Academy of Technology and Innovation Assessment GmbH
Research location	Bad Neuenahr-Ahrweiler, Germany
Cooperation partners	Scientific research institutions, local business associations, local financial institutions, local organisations and associations from civil society, local municipalities and cities and energy providers
Team	Immediate research team: three senior researchers, two junior researchers and two community contacts; furthermore nineteen researchers and thirteen local partners participated in the research on a regular basis
Funding sources	Federal Ministry of Education and Research (Innovation Groups "Sustainable Land Management")
Websites	http://www.ea-aw.org/research/overview/enahrgie.html http://www.enahrgie.de http://innovationsgruppen-landmanagement.de/en/innovationsgruppen/enahrgie/

ORGANISATIONAL BACKGROUND ●●●

The EA European Academy was established as a non-profit corporation in 1996 by the Federal German state of Rhineland-Palatinate and the German Aerospace Center (DLR).

The project "EnAHRgie" is designed to develop methodologies, tools and guidelines enabling municipalities, local economies and civil society groups to launch a transition to a sustainable energy system. It is organised as an innovation group, see the organigram below. The innovation group is suggested by the funding agency and implemented by the research consortium. The approach represents a modification of the EA concept of an expert group for rational technology assessment used in about forty projects. In the case of EnAHRgie, it consists of two layers, an inner layer and an outer layer. The inner layer is a permanent group consisting of the main partners representing different stakeholder groups. The outer layer has a more flexible composition and consists of contacts of the inner group members. Depending on the issues being discussed, the inner layer can change the contacts in the outer layer to get feedback or information on how to proceed in the dialogue on the project.

Both layers of the innovation group are divided into a section of research institutions and a section of societal stakeholders. There are five research institutions involved, represented by about fifteen people and two universities with ten people. The societal stakeholders consist of local energy providers, local social groupings, regional banks, local business associations, municipalities and county representatives. Each of these societal stakeholders has a representative in the core research team (inner layer) representing multiple stakeholders in that stakeholder group. Within the outer groups every actor involved formally has an equal vote.

The innovation group provides input for a decision by developing scenarios, but the innovation group does not take the (legal) decision. The actors involved provide recommendations based on the scenarios, so they can all offer their own perspectives. They gain information and can build relationships and trust through positive engagement. There is no consent-based principle in the social clubs, but an approach based on mutual understanding, problem-fitting through reflexive discussions and looking at different point of view.

FUNDING ●●●

The funding is provided by the Federal Ministry of Education and Research (Bundesministeriums für Bildung und Forschung – BMBF), Innovation groups "Sustainable Land Management".

PROBLEM BEING ADDRESSED ●●●

The objective of EnAHRgie is to find common and innovative solutions to major obstacles facing the energy transition to a more sustainable energy system, and to provide tools, methodologies and guidelines to implement these solutions on the local level in Germany and the EU. The innovation group is made up of scientists and practitioners to investigate conflicts and barriers to renewable energy projects from technical, economical, legal, environmental, political, and social perspectives. By combining scientific knowledge with local expertise, the project aims to develop a socially robust, scientifically sound, and highly applicable concept of sustainable energy provision in the county of Ahrweiler as a model region. Based on this, it is then intended to derive more general tools, methodologies, and guidelines which will be tested and implemented in three additional case studies before being implemented throughout Germany and the EU. The project further includes a number of measures to support the extensive dissemination of these tools, methodologies, and guidelines in Germany during the final year of the project.

RESEARCH DESIGN AND SOLUTION ●●●

The project is designed to involve local and regional stakeholders in the region of Ahrweiler, Germany in elaborating and implementing a concept of sustainable land use focusing on energy supply. The innovation group allows for cooperation between scientists (experts from the fields of sustainable land management, distributed energy systems, governance and participation) and practitioners from administrative bodies, regional politicians and regional energy suppliers.

The project follows a phased model of development. It begins with a definition phase, which is focused on the identification, recruitment and involvement of project partners, and the elaboration of methods and goals. This is followed by a development phase in which the innovation group builds a knowledge base, elaborates on the issues in the Ahrweiler region and finds innovative solutions to these problems. For the launch or test phase, these context-specific solutions are transferred into tools, methodologies and guidelines and continuously improved to implement these solutions on the local level in Germany and the EU. To achieve this, people from the various federal States are involved to show, explain and provide feedback on what is done in the developing phase. Finally, in the dissemination phase, local partners from the model region of Ahrweiler serve as ambassadors for the dissemination of the tools, methodologies and guidelines within their peer groups with concrete supporting measures planned.

The project has five key elements:

1. Innovation group to include relevant practical and scientific expertise and work in a transdisciplinary way;

2. Development of a concept of innovation to evaluate and enable applicability and robustness. Identification of obstacles and tailoring the innovation to the environment;

3. Equipping the members of the innovation group to put the innovation concept into practice; development of the cognitive capacity needed to find and implement solutions;

4. Data integration and visualisation, a platform to bring in information and engage in discussion to create knowledge in such a way that everyone can use it and contribute;

5. Scientific advisory group to ensure scientific standards and quality and provide recommendations and answers to more general questions.

GRAND CHALLENGE BEING ADDRESSED ●●●

The focus of the project is on the transition of energy production from major companies to more local production. Today the big four electricity producers own only 5% of the total production and the remainder is divided among many smaller producers, whose ownership is also decentralised. As a result, new organisations are emerging and various technologies for local production are putting pressure on land use. Especially in densely populated areas with high competition for land use, such as tourism, health facilities and spa operation, nature protection, and winegrowing and other food cultivation practices, governments must adopt new roles, e.g. at various governmental levels: municipal, local, regional and national. While formal procedures do exist, they often contradict each other. So this is mainly a social process, not only a political aim to take action on energy but local people and local actions can also find opportunities. The challenge is to include local people in order to develop the most robust, efficient, and sustainable solution while minimising the impact on the local population, economics, nature, and landscape.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

Stakeholder engagement and inclusion is addressed by the innovation group, which consists of researchers (mainly junior scientists and post-docs) and practitioners (administration, politics, energy suppliers, banks, NGOs), who do the majority of the work together. The group is complemented by a high-level expert advisory group providing targeted support on concrete questions and reflecting on more general issues. Selection of relevant actors for the innovation group takes place through an analysis of the local press, interviews with local experts, and an intensive process where all relevant stakeholders propose representatives from local municipalities, business associations, local banks, civil society clubs, and energy providers, by mutual agreement (see list of partners). The main rationale behind this procedure was:

- to gain widespread support for the project and ensure transparency;

- to include and provide access to relevant knowledge of local experts and networks;

- to create practical knowledge to supplement the (sometimes rather theoretical) scientific expertise;

- to avoid contradictions between major value commitments and interests;

- to build up local capacity for implementation and dissemination into other regions.

Stakeholders were committed because they are able to gain relevant information, share experiences and have a voice. Within the innovation group, the main methodology used was analysis of current potential, conflicts and barriers combined with discussions about evaluation criteria, indicators and scenarios for future energy supply. Anticipation of issues and the impact of possible innovations was covered by the innovation group when workshops were held to identify intangible factors, criteria and indicators of success, and to develop scenarios.

The representatives in the innovation group have the task of absorbing and translating relevant knowledge and information from their sector into the project. They also disseminate relevant results from the discussion in the innovation group to their own target group in the second layer of the innovation group (e.g. from the trade association to local companies, etc.). To ensure high quality and transparency, this process is supported by scientific experts on public participation who provide formats (focus groups, round tables, etc.) and support (e.g. moderation of round table discussions).

Short term visits by practitioners to the research institutes, intensive training courses in innovation methodologies, and an integrated data and visualisation platform provide for mutual knowledge development and a common understanding of relevant concepts, and build capacity for implementation. Using these tools, researchers and local partners work together in the EA Lab – a room in which multiple aspects of options can be visualised interactively on large screens – to co-design, discuss and disseminate different innovation options and scenarios.

The results of the project are communicated and discussed via diverse channels with those outside the project. Local parliaments and officials, business associations, stakeholder forums and public media were informed continuously via a web page, a flyer, newsletters, public workshops and reports in the local press. Various links to other local actors at different stages in the process of energy concept design and a flexible response to new developments through the second layer of the innovation group ensured that feedback from outside the project is considered. The composition of experts from inside and outside the region can change to acquire specific information or feedback. At regular intervals, about once every two months, forums, workshops, focus groups and local parliament hearings are organised and the settings for these are flexible to ensure that the voice of specific stakeholder groups is included. Beyond the immediate Ahrweiler region and its local stakeholders, the results of the research are communicated at scientific conferences and research networks.

EVALUATION AND DISSEMINATION ●●○

The research is carried out in a relative large research group that relies on prior experience in these research areas. The group is well embedded in the local region and scientific community, with a good knowledge of the literature and conceptual analyses. Findings from the research are published in recognised journals. The project develops methodologies on how to set up a co-design process to analyse and dealing with barriers in the realisation of renewable energy supply on a local level and translates them into applicable tools and guidelines as solutions. The replicability of the tools and methods is relatively good and the research design is interesting for all who seek to set up an integrated sustainable local energy concept. Fourteen selected publications are presented dating from 2007, including four international journal publications, nine book chapters or books and one conference paper. With regard to references, three international references are provided. These tools can enable municipalities, companies, or civil society groups to design responsible concepts for a sustainable energy system and thus significantly advance local energy transitions in Germany.

4.6. Environmental DNA and citizen science

Project	Environmental DNA and citizen science for exploration, inventory and safeguarding of biodiversity
Organisation	Universidad de Oviedo
Research location	Oviedo, Spain
Cooperation partners	University of Perpignan (France), Klaipeda University (Lithuania)
Team	Three senior staff researchers, two post-docs and three Ph.D students
Funding sources	National Spanish Grant for Societal Challenges; Asturias Regional Grant; Port of Aviles
Websites	http://www.uniovi.es/ https://oma.uniovi.es/proyectos/bioinvasiones (targeted at the volunteers in Spanish)

ORGANISATIONAL BACKGROUND ●●●

Conserving biodiversity is the key to a healthy, sustainable life for future generations. In this project a monitoring tool based on DNA present in the environment was developed and tested. This helps to build a database of species without disturbing wildlife to create an inventory of European biodiversity. Citizens are involved in the project in diverse ways, and contribute to the inventory. Volunteers photograph biota, remove potentially harmful exotics (by hand) and obtain DNA to catalogue native life.

According to the interviewee, Spain in general is not very conscious of animal lives or of the environment. The present research is necessary to prevent potential suffering or extinction of biota (animals and other) in the future. The researchers therefore developed e-DNA markers for the study of biodiversity, and in particular to find out how and to what extent invasive species evolve and gain ground. Early detection of such invasive species is important, otherwise it becomes impossible to remove them. Examples include certain species of mussels in the Mediterranean sea and the Atlantic ocean.

The method deploys citizens (near beaches) as early detectors. They helped to make a list of invertebrates in aquatic environments which are considered invasive. An early project proposal was submitted in 2013 and is running until end of 2016.

FUNDING ●●●

This project is partially supported by the following grants and institutions:

- National Spanish Grant for Societal Challenges CGL2013-42415-R, Multidisciplinary tools for alert and control of marine bio-invasions: environmental DNA, ICT and Citizen Science (2014-2016);

- Asturias Regional Grant GRUPIN14-093, Marine natural resources in the Anthropocene (2015-2017);

- Port of Aviles (Asturias), Control of the invasive species *Xenostrobus securis*.

PROBLEM BEING ADDRESSED ●●●

The future of humans depends upon living natural resources, which are inextricably linked with biodiversity. Future healthy and sustainable biodiversity relies on a good knowledge of present ecosystems. Biota inventories 'in the wild' are generally carried out by experts and follow sampling protocols that involve intrusive practices (electrofishing, netting, trapping etc.), especially in aquatic ecosystems where the species cannot be easily observed and quantified. Recent developments in environmental DNA (eDNA) make it possible to identify species from their DNA traces left in the water. This can be used to create an inventory of elusive and scarce organisms without disturbing wildlife. Current methods are still expensive and require high expertise in bioinformatics to analyse massive numbers of DNA sequences. Improvements are required to quantify the abundance of species of interest, expanding the methodology to all taxonomic groups, and making technology accessible to modest budgets.

In this project the researchers developed protocols and instruments for accurate, accessible, non-invasive and non-disturbing creation of an inventory of aquatic European biodiversity from DNA traces present in water. The original project is focused on marine biota. Case studies are centred in coastal areas of the Baltic, Cantabrian and Mediterranean seas.

RESEARCH DESIGN AND SOLUTION ●●●

The aim of the network is the exploration and safeguarding of local coastal biodiversity through respectful, non-invasive procedures, and it aims to:

- Develop protocols and instruments for accurate, accessible, non-invasive and non-disturbing inventory of aquatic fauna, through: visual tools such as photographs and videos and cheap, innovative molecular tools based on environmental DNA, to save lives and promote the welfare of wild animals.

- Bring together people of different age and activity sectors for environmental actions (coastal cleaning, control of exotic biota, biodiversity monitoring), in a network of citizen scientists. Day activities in senior education programmes for retired people, children in surf schools, members of the general public in continuous education, university students, primary and secondary schools, fishermen's associations and guilds, scuba diving clubs, port authorities and regional authorities were targeted, contacted and invited to participate.

- Involve authorities, managers, stakeholders and general public in creating the biota inventory using the newly developed non-invasive methods in order to increase conscious treatment of biodiversity.

The team also offers workshops for people who are interested in finding out how DNA is extracted, etc. The group started off enthusiastically, opening up the lab to those who wanted to help collect samples at the beaches. Participants seemed to enjoy that very much. Also the group received feedback information from the participants, and learned that their ways of transmitting their information was not very good. They then organised a 'club', with workshops on various topics, to engage the public. That worked better, demonstrating some degree of internal reflexivity to optimise the value of their outcomes.

As an example of citizen science, with photos rather than eDNA: in Oviedo people were asked to upload old pictures (up to decades ago) with the year indicated. These people were then asked to take a new picture in the same location. This resulted in thousands of pictures that were used to identify how vegetation has changed over the years. Exotic invasive plants and their migration patterns were identified in this way.

In Spain, over 200 citizen scientists aged eight to eighty-two were recruited. They worked on collecting DNA; helped organise a photograph exhibition about biodiversity; children learned to recognise native and exotic biota, and visited Oviedo University, for example during the Week of Science. In the port of Aviles (Spain) they collectively discovered a plague of alien mussels. Supported by port authorities, the multi-age volunteer group handled the invasive species by removing them by hand.

GRAND CHALLENGE BEING ADDRESSED ●●●

The societal challenges addressed revolve around the sustainable use of natural resources and protecting and conserving biodiversity. The team uses the following approach:

- Reconciling reliable biodiversity inventory with respect for animals in their natural habitats; the values of environmental conservation and sustainable management of natural resources and biodiversity are natural outcomes of this project.

- Involving the general public of all ages in science, thereby filling the gap between highly specialised science in research and academia and public scientific knowledge. When young students (primary and secondary education) share their activities they engage them in responsible research and scientific practices, and awaken their interest in science and knowledge, as well as in environmental issues. The same can be applied to seniors, since they involve mature students who are above retirement age in our activities.

The research teams indicated that the problem of exotic species is that they outcompete the native population. For example, the native population of a certain species of mussels disappeared from one marina in less than two years. If the new species gets out of the marina, it could spread to other places. But the new ones cannot be eaten, since they are small, but simultaneously accumulate heavy metals faster by growing faster. Then starfish, for example, which may eat these mussels could die because of the heavy metals, which poison them slowly by gradual accumulation and so on up the food chain to fish and then human beings. Mercury can be a particular problem, since it is taken up before it disappears into sediments due to the fast growth of the mussels. Similar examples exist in the case of plants, which hinder e.g. bird nesting and cause other problems downstream from this.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

In principle, the team believes that current academic knowledge should be publicly shared with citizens to support conscious and respectful treatment of local biodiversity. Moreover, it is simply impossible to make an inventory of all coastal biodiversity without the help of local citizens; there is not and will never be an adequate workforce for such a huge task. This project therefore intends to involve volunteers of all ages in a network of citizen scientists. Target groups and stakeholders in the research are scientists, managers of natural resources, national and regional authorities, fishermen's associations and guilds, surf schools, marina and yacht clubs, graduate and undergraduate students, senior citizens involved in lifelong learning and the general public. Scientists and managers are in charge of biodiversity inventories. Regional and national authorities have the competences for environmental issues. Fishermen and people engaged in recreational maritime activities are key stakeholders for marine biodiversity. The good response to the project from seniors gave the idea of introducing the value of multi-age groups in citizen science.

The young people involved are also concerned about the future of our society: they were helped to come into contact with experienced people so that they could learn from them. Patience and flexibility in environmental conservation are invaluable lessons for children and young people. The energy and enthusiasm of children turns out to be positively contagious for the older volunteers as well, creating a pleasant working environment.

The general public was addressed through various media, however the social impact of some scientific discoveries were found to have negative side effects. Local media reported on the team's discovery of an invasive mussel in Aviles port (November 2015) and some regional officers requested a port closure, subsequently alerting the port authorities. Following this, the research team has changed the message for the media. For example, the words used are more subtle such as "Presence of exotics" instead of "Biological invasion". The team learned a lesson in science communication, which the use of carefully chosen wording to avoid unnecessary public alarm and sensationalism being caused inadvertently by inexpert journalists.

EVALUATION AND DISSEMINATION ●●●

The project is carried out by a relative small group of researchers, many of whom are Ph.D or Post-doc. The research carried out to date is the beginning of a more ambitious project on the best way of combining citizen science and molecular techniques for biodiversity study and environmental safeguarding. Although interaction with the public is not the main expertise of this group of scientists, the team needs to tackle this aspect if they want to be really efficient in their approach. Despite the small size of the research team, they reported their findings directly derived from the project in nineteen international journal publications (since 2015) *Marine Pollution Bulletin and Marine Environmental Research, Aquaculture Research, Citizen Science,* a feature article in *National Geographic Magazine,* and 75 other publications since 2010 have mentioned the project's objectives. The impact of the project is relatively significant in terms of the outreach to civil society. The citizen science approach was presented at the International Conference of Citizen Science in San Jose (California) in February 2015. At local level the initiative was widely publicised in media (radio, newspapers, TV, Internet via University communication agency) and they gave informative talks at port facilities, high schools, Oviedo and Klaipeda universities (Perpignan in January 2016) and surf schools. The picture exhibition, coastal clean-up and surf school engagement were publicised using the same channels, for positive feedback to the participants. Stakeholders such as fishermen's guilds and associations, government agencies and clubs were contacted directly by the researchers, by telephone, email and/or personal visits. The dissemination activities are broad and frequent, despite the fact that in Spain and particularly in Southern Spain, the issue of protecting biodiversity still receives very little attention (socially and financially). This project is an attempt to improve this situation by increasing the awareness of the importance of protecting biodiversity.

4.7. Food Futuring Tours

Project	Food Futuring Tours (FFT) – A participatory visionary lab to think and tinker with the future of food at Expo 2015 in Milan
Organisation	Institute for Electromagnetic Sensing of the Environment/ National Research Council (IREA-CNR) and The Joint Research Centre of the European Commission, Directorate I – Competences
Research location	Milan, Italy
Team	One research fellow and three senior researchers
Funding sources	The Joint Research Centre of the European Commission
Websites	http://www.irea.cnr.it/ http://foodfuturingtours.irea.cnr.it/en/ https://ec.europa.eu/jrc/en/research-topic/ science-and-technology-studies

ORGANISATIONAL BACKGROUND ●●●

Food Futuring Tours is a collaborative project between two researchers from the Italian National Research Council (IREA-CNR) in Milan, Italy and two researchers from DG Joint Research Centre of the European Commission. The four researchers involved in FFT were all women. The project is a public participatory experience aiming to re-imagine food in the 21st century. It consists of five semi-guided walking tours through the pavilions of EXPO2015 with the focus on *"Feeding the planet, Energy for Life"* (May-October 2015, Milan).

FUNDING ●●●

The Joint Research Centre of the European Commission, Directorate I funded this initiative.

PROBLEM BEING ADDRESSED ●●●

The aim of Food Futuring Tours was to gather insights, imaginative ideas and expectations about food futures through a debate with citizens who are usually described and treated simply as consumers. The project explored new ways to engage citizens' views about an urgent and complex human issue: *feeding the planet with quality*. Conducted at an event like EXPO, this initiative opened up a space that stimulated and challenged citizens to imagine food futures – including food production, distribution and consumption. This approach allowed a small number of citizens to view the EXPO as a place where prevalent narratives of food futures could be contested and questioned. This project explored ways of creating safe spaces where dialogues like these can be carried out and illustrated with opinions and examples. In particular, institutions that have insufficient interaction with civil society, are not left entirely to those considered as "experts", but can work quickly with citizens to promote such dialogues about the future.

RESEARCH DESIGN AND SOLUTION ●●●

Food Futuring Tours was a participatory experience that aimed to re-imagine food, gathering ideas, perspectives and imaginative insights about the future of food and the food of the future, and the possible social, ethical and cultural aspects and environmental impacts of that food, based on the great Universal Exposition 2015 in Milan, which was entirely dedicated to this theme. For six months, from May to October 2015, hundreds of countries around the world came to the Expo to showcase technologies, innovation, culture and traditions around the theme of food.

Food Futuring Tours consisted of five semi-guided walking tours led by experts from the Italian National Research Council (CNR) and the Joint Research Centre (JRC) of the European Commission, through the halls of EXPO2015. Participants visited a variety of pavilions such as NGO pavilions, industry/private pavilions, the supermarket of the future, the Slow Food Pavilion and pavilions representative of the global North and South, East and West. During these tours participants focused their attention on the issue of food as shown in its past, present and future dimensions, taking photographs (using smart phones or digital cameras), drawing or using any other visual means of recording.

The participants defined the focus of the "futuring" deliberation at the end of each afternoon workshop that followed the Expo walk: ten scenarios on the future of food were produced during the workshop sessions that were held in groups after each morning tour.

The whole proposal was based on the work of Cynthia Selin, Sarah Davies, Gretchen Gano and Ângela Guimarães Pereira in Lisbon through a project called Finding Futures (Selin et al. 2013), which explored methodologies based on "experiential" engagement, noticing and anticipating the future. This project explored innovative ways of deliberating on the future of cities through an emphasis on visual engagement. In the Expo context this methodology was explored using the topic of food. The ten final scenarios that participants imagined reflected their take on the societal, economic and environmental challenges of the future at local and international levels. By working out the ten scenarios for 2040, the participants critically reflected on present ways of living and consuming and then articulated their insights, values, perceptions, expectations, needs and fears into the futures that they imagined.

GRAND CHALLENGE BEING ADDRESSED ●●●

The grand challenge addressed in this project is food security. The Food Futuring Tours discussed the social, ethical and economic aspects embedded in current narratives about food futures in view of a stated need to feed future generations with sufficient food that is fairly produced and traded and of high quality. Food *futuring* is often left to specific stakeholders – scientists, designers, corporations, chefs – but FFT expanded the dialogue on food futures to people who are often not invited, promoting a 'place' for critique, reflection and re-imagination. The objective was to tap into alternative perspectives on the future of food, beyond the predominantly technologically driven perspective. The main challenge of the project was to create meaningful places where *citizens* could be included in debates on future food issues. In connection to food, the scenarios developed by the citizens involved, reported and described citizens' imaginations of the future of their lives and their cities at social, ecological, government and economic level. Together with these, a list of social inequalities, environmental disasters, educational distortions and economic disparities emerged which might, in their view, become more or less pronounced in the coming years.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The Food Futuring Tours involved nearly hundred citizens who participated on a voluntary basis in five semi-guided tours. The participants were recruited via the website foodfuturingtours.irea. cnr.it. This website recorded all issues relating to recruitment and the research process, describing its objectives and methods as well as the results of the journeys. The call was free but open to a limited number of participants who had to register and participate as *citizens*. The majority of participants were women, with diverse nationalities (although they all lived in Northern Italy), professional/cultural backgrounds (educators, students, researchers, artists and public and private employees) and ages (17-71). They interacted with proposals made by stakeholders and non-governmental organisations at EXPO2015 about foods of the future and the future of foods. Perspectives presented by these stakeholders were questioned and analysed by the participants.

The Food Futuring Tours website was the main channel for continuous reporting on the initiative and for interaction with participants. The platform described the five tours, day by day, using pictures taken by researchers and those attending the tours. Citizens registered freely using the specific page for the day when they wanted to take part in the initiative, and entered their personal contacts, motivations and any questions or doubts on that page. Instructions for the day were also given to the participants through personal e-mails sent before the tour, together with the list of the equipment needed (digital camera or smart phone, audio-recorder, pen and paper etc). During the walks, the participants took pictures and notes of (food-related) *things* that they liked, disliked, or that somehow struck or inspired them. These materials were used as inputs for the afternoon session, which was a participative workshop. Whereas the morning session involved an individual exercise where the participants walked, observed, took pictures etc., the afternoon session was a collective/group exercise, where participants developed future food visions and discussed drivers and uncertainties, fears and expectations, personal values, opinions on food production etc.

The results of the workshops were described in a sort of Charter of Ideas reporting suggestions, tips, interests and ten scenarios, either desired or feared, around the theme of the future of food. These scenarios were projected to 2040 and also looked into uncertainties that could hinder or foster the imagined futures. Some scenarios were given names like: awareness,

self-sustainability, wellness, resilience, quality, responsibility (etc.). Private expectations on future food were shared among the participants and analysed in terms of possible desired/non-desired impacts. The ten scenarios that emerged at the end of the whole initiative were publicly presented during the final conference and reported in a free booklet. These ten scenarios can support policy makers and/or experts who deal with food strategy planning at local (e.g. Milan Food Policy), national and/or European levels. Furthermore, this update on food expectations taken from the sample of citizens involved allows politicians to imagine the societal and environmental expectations of their citizens themselves.

EVALUATION AND DISSEMINATION ●●●

The research was carried out by three senior researchers and a research fellow. It is a relatively small project with a strong focus that was implemented over a short period of time. The project has been taken up well beyond its immediate scope and multiple press releases and media attention comprising diverse audiences. Three references were included, one from the city council and two international researchers. Based on the application form, the authors mention five papers, which have been published at conferences, the EGU General Assembly and in the *Journal of Science Communication.* The initiative can be replicated as a 'Decision Support' tool in projects when public consultation or experiential engagement is required. The model can be replicated for researchers or public bodies who need to collect users' requirements or suggestions (e.g. in urban planning design).

4.8. IMRR Project

Project	IMRR Project – Integrated and sustainable water management of the Vietnamese Red-Thai Binh River System in a changing climate
Organisation	Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB) at Politecnico di Milano
Research location	Milan, Italy
Cooperation partners	Institute of Water Resources Planning (IWRP), Ministry of Agriculture and Rural Development (MARD) in Vietnam
Team	Three senior researchers, four post-docs and five Ph.D students and three expert consultants
Funding sources	Italian Development Cooperation Agency; Institute of Water Resources Planning; Ministry of Agriculture and Rural Development
Websites	http://www.deib.polimi.it http://xake.elet.polimi.it/imrr

ORGANISATIONAL BACKGROUND ●●●

The research is coordinated by the Planning and Management of Environmental Systems group of the Dipartimento di Elettronica, Informazione e Bioingegneria at Politecnico di Milano. The goal of this research group is to develop mathematical models for quantitative analysis and management of environmental systems, thus promoting more efficient and sustainable use of natural resources and contributing to the adoption of transparent, shared decision-making procedures. The main partner in Vietnam is the Ministry of Agriculture and Rural Development's Institute of Water Resources Planning (IWRP). The participatory modelling approach adopted is representative for the group's standard approach to modelling for integrated resource management. Three Ph.D and four MSc scholarships at Politecnico di Milano have been granted to Vietnamese students as part of the project and all of them are working for the Vietnamese Government in the water management domain.

FUNDING ●●●

Three funding sources are mentioned: Italian Development Cooperation, the Institute of Water Resources Planning, and the Ministry of Agriculture and Rural Development.

PROBLEM BEING ADDRESSED ●●●

The IMRR project aims to develop and promote strategies for the sustainable and participatory management of water resources in the Red-Thai Binh River (RTBR) system, also referred to as the Red River, the largest river basin in Vietnam. This river region includes the Hanoi capital and other 25 provinces, with a total population of 26 million. This region is experiencing rapid

population and economic growth. To accommodate this growth and preserve the river, the IMRR approach combines coordinated decision-making and stakeholder participation, supported by advanced modelling and optimisation tools, and capacity building in local institutions. The aim is to build tools and knowledge to analyse trade-offs, considering human water uses, ecosystem needs and natural disaster risk management. It provides tools and capacity to allow Vietnamese institutions involved in water resource management to negotiate sustainable policies in a participatory bottom-up way and to replicate water resource planning processes in other water systems around Vietnam.
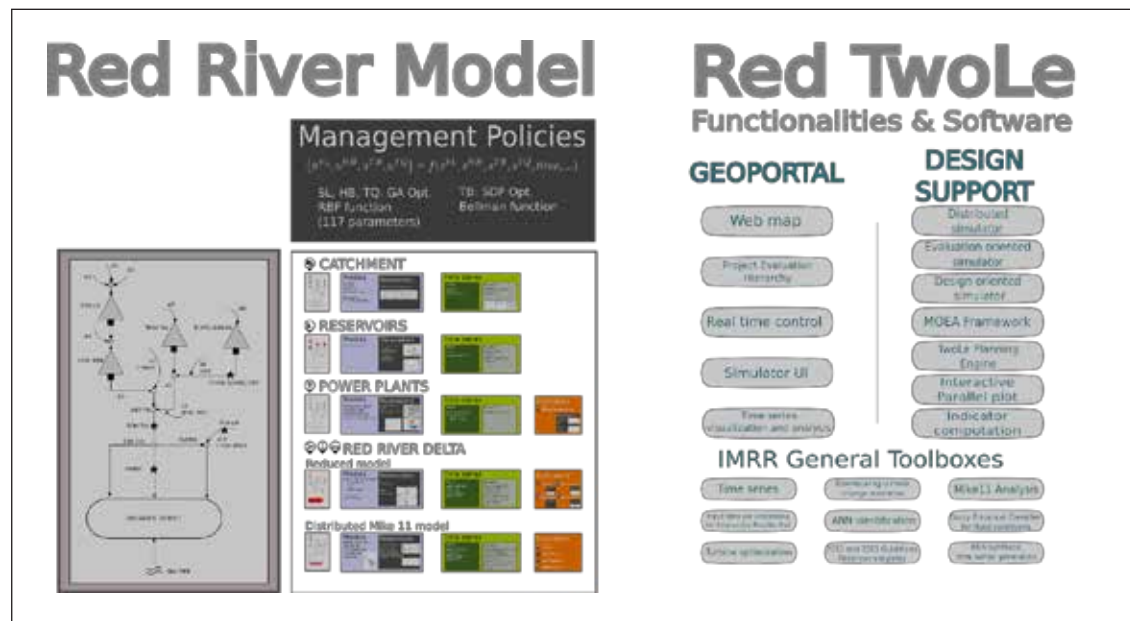
RESEARCH DESIGN AND SOLUTION ●●●

IMRR adopts an Integrated and Participatory Water Management approach. The participatory modelling approach aims at capacity building and competence transfer to the local institutions and has been developed over the years by prof. Soncini-Sessa and colleagues (see two books edited by Soncini (2007): "Integrated and participatory water resources management"). The project has three aims:

- to study the huge Red River water system, identify efficient management strategies and analyse their adaptability to ongoing climate and socio-economical changes;

- to develop an open-source decision-making platform ("Red-TwoLe"), to periodically support planning on the Red River water system. The platform integrates simulation models of the physical processes and decision-making support tools. The platform has a geo-referenced graphical interface to interact with stakeholders and the general public, which can explore the impact of different management strategies on the different sectors at different locations in the basin. Red-TwoLe has been installed and configured and is currently operating on the server of the Vietnamese partner (IWRP);

- to build capacity through Italian scholarships for Vietnamese Masters and Ph.D students, technical workshops throughout the project duration and a residential final course.

All stages and activities involve participation of stakeholders; stakeholders were involved e.g. in detection of actions, definition and validation of indicators, identification of models, evaluation of effects and in designing and choosing strategies.

GRAND CHALLENGE BEING ADDRESSED ●●●

Water resource management is a key issue in the path toward sustainability, especially in a fast-developing country like Vietnam, which relies on water resources for many economic activities. Water availability can create conflicts between different users at various times and under a variety of conditions.

The main issues to be tackled and addressed by the project are:

- Improved handling of water allocation and distribution conflicts between the varying water needs of private and public actors;

- Minimisation of economic losses (for agriculture and hydropower sectors), reduction of the risk of flooding and enhancement of environmental quality through more effective and sustainable water allocation and distribution.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The IMRR Project adopts a participatory approach which is intended to include all relevant stakeholders in the planning process, thereby integrating distributed and field-specific expertise at every stage in the project. The stakeholders represent diverse organisations: four different Ministries (Agriculture, Natural Resources and Environment, Industry, Transport), the Central Commission for Storms and Flood Control, the National Power Company, Provinces and Irrigation Districts, Vietnamese universities and research centres. The project aims not to provide a single, closed solution for water resource planning and management in the Red River basin but to equip Vietnamese institutions with tools and capacity.

The integrated water management approach allows actors to share knowledge and information. The IMRR project supports this process at various levels through the provision of various different tools:

- Ongoing research has been discussed at annual public meetings (the so-called "Basin Meeting"), which are open to all relevant stakeholders and chaired by the Vice-Minister of MARD (Ministry for Agriculture and Rural Development);

- Data collection and indicator definition has been supported by the project website, which is powered by MediaWiki technology and promotes continuous review and sharing of the knowledge base;

- Project reports, providing descriptions of all technical aspects and implementation details, have been published on the website throughout the duration of the project;

- Several training courses have been systematically provided at the IWRP offices on a regular basis thorughout the duration of the project, addressing specific topics (e.g. climate change impact assessment, participatory water management);

- The Red River Geoportal, a web based, open source, spatial data infrastructure, has been developed to share, visualise, analyse and compare different strategies for the management of the Red River water system. At the last Basin Meeting, Red-TwoLe was officially delivered by Italian Ambassador to two Vietnamese Ministries, MARD and MoNRE (Ministry of Environment and Natural Resources), and it has been installed and configured on the server of the Vietnamese partner. A demo version of the Geoportal has also been installed on a server at Politecnico di Milano.
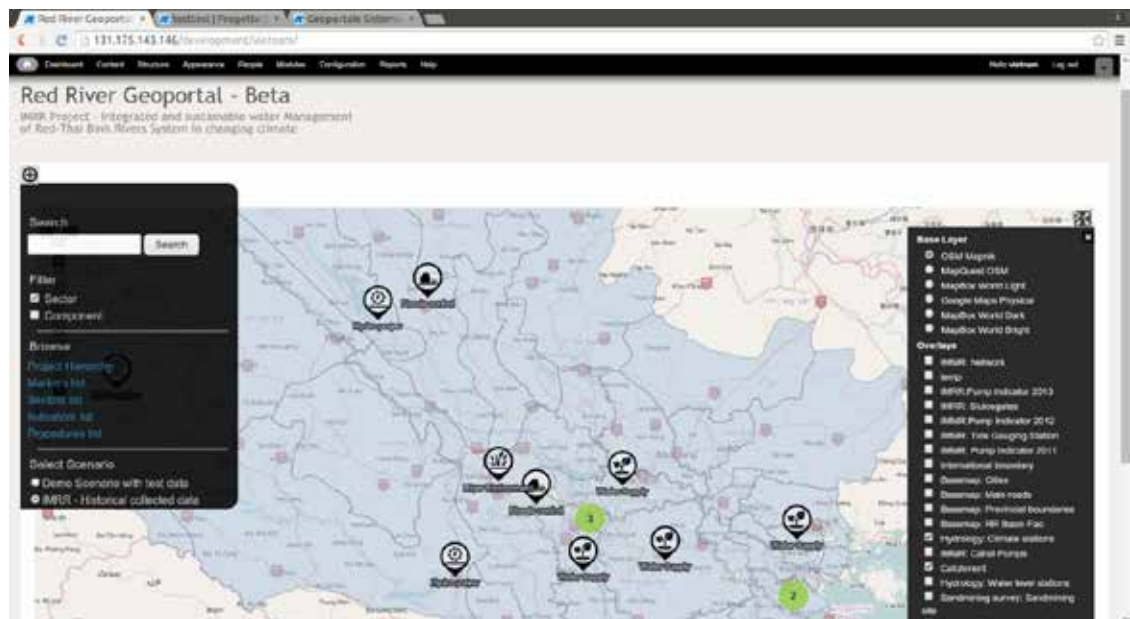
Stakeholder participation has benefited the research through:

- Consideration of aspects not included in the original proposal, such as the analysis of geomorphological changes, the implementation of additional software tools, or direct involvement of MoNRE in project development and delivery of outputs.

- An annual focus group, called the Strategic Group, comprising experts in all sectors. This group defined a set of meaningful indicators and evaluation criteria, through which the experts identified possible compromise management strategies to be recommended to the water authorities for adoption and implementation. Input from the Strategic Group was used to adapt the research where needed, for instance, in developing new scenarios and indicators.

- A politically sensitive line of inquiry was further developed in the project focusing on illegal sand mining in the river. This was done in response to feedback from the stakeholders.

The researchers were aware that they were operating in a political environment; for example, they encountered corruption and had to consider how to deal with this in an ethical way.

EVALUATION AND DISSEMINATION ●●●

The team is relatively small but well embedded in the Vietnamese stakeholder context and builds upon extensive experience with participatory modelling. The methodology and results developed during the project represent state-of-the-art techniques and valuable scientific findings, as demonstrated by the 24 publications in international scientific journals and the 49 contributions to several international conferences. Journals in which the research team published include *Water Resources Research, Journal of Water Resources Planning and Management, Environmental Modelling & Software, Geomorphology, Water Resources Research and Hydrology and Earth System Science.* The findings are also presented to governmental organisations and ambassadors and there has been a national television appearance in Vietnam. The methodology and research approach of Red-TwoLe has been designed to be adaptable and flexible, in order to replicate the planning process in other Vietnamese water systems.

4.9. IncluSens

Project	IncluSens: Democratising progress in healthcare through the development of wearable, low-cost technological platforms
Organisation	Nanosensors Research Group, Universitat Rovira I Virgili
Research location	Tarragona, Spain
Cooperation partners	International university partners, local private organisations and the Hospital St. Joan de Déu Barcelona
Team	Four senior researchers
Funding sources	Universitat Rovira i Virgili, European Union (Marie Curie fellowship and European Institute of innovation and technology, EIT Health); Ramón y Cajal Programme, Ministry of Science and Innovation of Spain; Ministry of Economy and Competitiveness of Spain and the Fundación Recercaixa, La Caixa Capital Risc
Websites	http://www.quimica.urv.es/quimio/nanosensors/ http://www.caixaimpulse.com/projects/-/caixaimpulse/project/25412

ORGANISATIONAL BACKGROUND ●●●

The project is carried out by a project leader, a senior researcher and three post-doc researchers from Universitat Rovira i Virgili within the nanosensors research group in the department of Analytical and Organic Chemistry.

The project leader is Dr. Francisco Andrade, whose aim it is to expand the knowledge base (curiosity) but also to find new ways of arriving at innovative solutions that have high social practice and impact (necessity, i.e. as opposed to doing science and technology in the lab only). The idea is that in the lab knowledge is de-contextualised, but through innovation it must be re-contextualised again in order to be adopted by society.

The team collaborates closely with four partners. These partners are diverse and each contributes in a different way. Together with the University of California San Diego, the collaboration is on research into wearable technology. With two private partners, the collaboration concerns the design of prototypes and the use of RFID tags in portable applications. With the Hospital Sant Joan de Déu Barcelona – and other local hospitals and institutions – the focus of collaboration is on further development of the innovation concept, development of real scenarios for applications and acceptance of these innovations.

FUNDING ●●●

This research is supported by several public and private sources. Since the beginning of the project, financial support has been provided through national and international projects. Funding has been received for:

- EC FlexCare: electrochemical platforms for decentralised chemical measurements by both the Ministry of Economy and Competitiveness and the Ministry of Science and Education of Spain;

- FlexSens: chemical sensors for the 21st century by the European Union, Marie Curie starting grant and EIT Health;

- Sens-Age: smart sensors for healthy ageing by The Fundación "La Caixa" & Caixa Bank Capital Risc;

- Creatimeter by Universitat Rovira i Virgili.

PROBLEM BEING ADDRESSED ●●●

Knowing about one's own day-to-day health appears to be very challenging as the body often seems like a black box. Today's technology allows people to send messages and pictures and the same technology can also be used for health data, i.e. sending daily health data using the power of networking to allow people to obtain information about their daily state of health.

This research concerns the development of cloud-based platforms for wearable and affordable devices that can be used at home by patients at a very low cost. The devices measure and monitor biochemical parameters that are indicators for common chronic conditions – such as diabetes, chronic kidney disease, etc. IncluSens aims to create a more efficient and inclusive social healthcare system by developing telemedicine tools that are highly affordable, simple and robust.

RESEARCH DESIGN AND SOLUTION ●●●

The main research is carried out on chemical compounds in biological fluids, for instance creatinine, which is a biomarker for kidney function. These molecules can be measured almost continuously by wearable devices without much interference with a person's daily life. By drawing on and leveraging current progress in communications, materials and sensors, the team is developing new tools for the monitoring and management of chronic diseases that are extremely simple and affordable. The research is embedded in scientific research and tries to translate the research findings into devices that are affordable and comfortable to use for a wide audience. Implementation of the research into these devices receives considerable emphasis in the research project and to support that, the team collaborates at specific points with experts from the fashion industry on designing clothes and mannequins to model the prototypes, while the postdocs also take courses in the commercialisation of technology. The team has incorporated a senior industrial designer who works in the lab to help to visualise users' needs and provide tools for thinking about design.

GRAND CHALLENGE BEING ADDRESSED ●●●

Social inequality is one of the biggest challenges of the 21st century. Most of the wealth is concentrated among only a small fraction of the world population, while large numbers of people suffer from conditions that seriously compromise their life and well-being. Science cannot be indifferent to this problem since the incorporation of technology in society might become a source of inequality. In healthcare, for example, technological progress is creating unprecedented ways to detect and cure diseases early. At the same time, increasing numbers of people in both developed and developing nations cannot afford basic medical care. The World Health Organisation has recently admitted that technological progress is directly linked to the skyrocketing costs of healthcare. Treatment is better but accessed by fewer people. To avoid this, an understanding of progress that goes beyond improving current performance to include the extension of existing benefits to larger numbers of people is therefore required. Many challenges lack academic appeal because the focus is on the scientific challenge. Nevertheless, little is being done to allow the benefits to reach the whole population. New models of inclusive social progress are needed. IncluSens aims to create novel technological platforms for healthcare that are accessible on a mass scale. At the social level, this project aims to provide tools for home-based healthcare that are simple to operate, easy to access and highly affordable. People will therefore benefit from better and affordable control of their health and improved quality of life. Society will also benefit from effective tools that can help to redefine healthcare by leveraging progress in communication tools and channels. Another social challenge that is mentioned is the pressure the devices put on the interaction between patients and their doctors and the position adopted by doctors on the device.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

To develop and design the wearable devices, the research group included, right from the outset, an industrial designer with a high level of expertise in design thinking and human-centred design. Through this collaboration, the team conducted observational research by testing the devices among patients and doctors. Ethnographic studies were carried out and the insights gained were discussed in focus groups to translate them into inputs for research. This helped to improve the development of useful, applicable solutions, since it highlights different layers of value, latent needs etc. The team also included two target groups: doctors and patients. Since the goal of the project is to provide tools to improve healthcare and well-being, these patients and doctors were included as co-developers of the project. For this reason, periodical review meetings were organised with them, at which progress was shared and their feedback and needs were captured in order to identify how to proceed or what the limitations are.

The research team has also participated in several results dissemination sessions, not only in healthcare and academic centres, but also through dissemination activities allowing the general public to learn about the goals and progress of the project and offer its opinions. The research team has communicated its vision and research progress to a wider audience through several mass-media channels (national TV, newspapers, radio). People from the audience have contacted the team afterwards on several occasions.

To reflect on the broader issues involved in implementing wearable devices, the team has set up a panel of experts from different areas (medical, legal, social, ethics, etc.), who are consulted periodically to evaluate the ethical and social implications of the results. The analysis of the project's impact used a matrix in which the different aspects (social, environmental, economic) were evaluated as a function of the time-frame (short, medium, long-term). The feedback captured

from the different panels (doctors, patients, stakeholders) and from the experts was classified accordingly. This matrix allowed the identification of previously unsuspected problems, and also the detection of many opportunities.

One point that is worth mentioning involves the use of information. The project aims to develop home-based devices that generate biochemical data. A system incorporated in the toilet, for example, produces information regarding urine composition. One unforeseen problem is how to manage this type of information. Doctors have raised concerns about the problems that could arise if people have frequent access to their biochemical parameters. Patients have mentioned that they might feel uneasy if biochemical measurements are carried out regularly. This information was captured at an early stage by the designers, and has been incorporated in the design of the user interface and information management system. Similar problems have been detected, for example, concerning confidentiality of the data generated. As a result of these findings during the research, the project aims to analyse risk at different levels.

EVALUATION AND DISSEMINATION ●●●

The research is carried out by a relative small research group. It is broadly embedded in terms of both the scientific literature and practical implementation. It seeks to incorporate human-centred design early in the research lab to balance scientific curiosity and social necessity. Design thinking tools help to find real challenges beyond the obvious problems and not only to develop cheaper tools, but to reshape the way doctors and patients engage with caring for their health.

The research team has provided eleven scientific journal publications since 2013 in journals such as: *Chemical Communications, Biosensors & Bioelectronics, Analytica Chimica Acta, Electroanalysis*, and the *Analyst*. Two of these were featured as cover articles. Two book contributions were provided.

4.10. Land Rush and local livelihoods in Central Africa

Project	Land Rush and local livelihoods in Central Africa: From a simulation game about land conflicts to community theatre action research
Organisation	Université Catholique de Louvain
Research location	Louvain-la-Neuve, Belgium
Cooperation partners	ARES (Académie de Recherche et d'Enseignement supérieur), FNRS Mandat d'Impulsion Scientifique, Institut Supérieur du Développement Rural – Bukavu, civil society partners: Louvain Coopération and Action pour la Paix et la Concorde
Team	One senior researcher and five Ph.D researchers, one postdoc, one independent graphic specialist and one NGO employee
Funding sources	Université Catholique de Louvain Fonds Wernaers FNRS Freedom to research Académie de Recherche et d'Enseignement supérieur
Websites	www.uclouvain.be a MOOC on natural resources and development and the Land Rush Game

ORGANISATIONAL BACKGROUND ●●●

Landrush is an interdisciplinary action-research project about natural resources in central Africa, coordinated by An Ansoms, a senior researcher from Université Catholique de Louvain, Belgium. The project is in collaboration with five Ph.D students (four at Louvain, one at Antwerp), one postdoctoral researcher, one freelance illustrator and consultant on cultural heritage conservation and a specialist in development education at Louvain Cooperation (NGO) are also involved. The project is embedded in the Centre for Development Studies of Université Catholique de Louvain, where the senior researcher is one of the co-directors. The Landrush project aims to identify and analyse actors' strategies and discourses in central African land conflicts, in order to detect the deeper dynamics underlying such conflicts and formulate policy recommendations for more efficient land conflict management policies. The project focuses on eastern DRC (South Kivu) in particular, where the team is collaborating with academic and civil society partners to adopt an innovative methodological approach in which a simulation game (Land Rush) is transformed into community theatre for action-research. However, the project also includes cases from Rwanda and Burundi which are – in interaction with the research in eastern DRC – analysed from a comparative perspective.

FUNDING ●●●

The Université Catholique de Louvain and Fonds Wernaers have funded the elaboration and professionalisation of the Land Rush Game and is currently supported by the FNRS Mandat d'Impulsion Scientifique (2015-2018). Further funding is from ARES (Académie de Recherche et d'Enseignement supérieur), the South Kivu (DRC) and the Université Catholique de Louvain.

PROBLEM BEING ADDRESSED ●●●

This project aims to provide a better understanding of how the rush for land is affecting the fabric of society, and ultimately the chances for peace and stability in Eastern Democratic Republic of Congo (DRC), Rwanda and Burundi. The project analyses how intensified competition for land affects actors' livelihoods; and which strategies and discourses these actors develop to deal with those challenges. It builds a strong partnership between academics in the North and South – in interaction with civil society organisations. The project adopts an innovative methodological approach in which a simulation game (Land Rush) is transformed into a community theatre action-research in order to access actors' hidden discourses. This project aims to inform and reflect alongside policymakers and donors through innovative advocacy tools, with the ultimate aim of improving the chances for peace and stability in Central Africa.

RESEARCH DESIGN AND SOLUTION ●●●

The game Land Rush, developed originally for teaching purposes at Université Catholique de Louvain, simulates the complex competition for natural resources in developing countries. It models real-life dynamics in the land arena and is based on years of research on the livelihoods of farmers in the Great Lakes region of Africa. In this project, the game was transformed into a research tool. Since participants may find resource competition and agrarian change to be sensitive topics to discuss and as board games are a typically western phenomenon, the game was transformed into a theatre production. In two steps:

1. the researchers linked up with local NGOs working on micro-level community building and conflict resolution. With an academic team from the South and the North, a training course for animators working for the NGO partners in the field was designed. The animators served as brokers between the researchers and the research participants. At the beginning of the course the animators are invited to play the LandRush game. They then reflect on the key dynamics of the game and the animators engage in a discussion on the relevance of these key dynamics for the setting in which they work. Finally they brainstorm on ways to translate the messages from the games into a theatre sketch that appeals to the local population.

2. In a second step the animators perform their sketch (20-40 min) in front of the community where the research is to be carried out. After the sketch a researcher asks the public to reflect on the links between the sketch and peoples' real lives.

The method is now transformed into an instrument for action research. The team investigates – in collaboration with civil society partners – how it can be better inserted in the partners' activities and reflections.

GRAND CHALLENGE BEING ADDRESSED ●●●

Competition over natural resources is a worldwide societal challenge. This is all the more so in a region such as the African Great Lakes Region, characterised by overpopulation, huge land scarcity, and a history of violent conflict. Land conflicts have often played a role in the escalation of tensions into violence; and the scars of that violence continue to influence post-war negotiations over land. Tensions often remain 'under the radar' for a very long time, invisible to outsiders. As a result, it is difficult for policy makers and development practitioners to develop successful conflict management approaches.

The research methodology developed in this project allows researchers to access people's hidden transcripts. By removing the controversy from the real context and placing it in a fictional one (theatre sketch), participants can discuss real-life conflicts and feel secure enough to reveal part of their hidden transcripts. This allows researchers and civil society partners to detect the deeper dynamics in land conflicts. Moreover, the creation of the sketches with local youth theatre groups inserts a positive dynamic in the civil society partners' community building projects.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The researchers are collaborating with Congolese academic and civil society partners. Communication with these partners is very intense. Both academic and civil society partners collaborated over the course of several months on elaboration of the ARES project. The two Congolese researchers in the team (one in the final stage of his Ph.D, one who has just completed it) play a crucial role in this partnership. They have co-developed the methodology and are constantly linking the dynamics in the research team to the realities of the local partners. They have gained the legitimacy to set up a university research expertise centre in Bukavu on land conflict management (end stage of this project). The team see this research centre as an important step towards being more permanently present on the ground, with ownership in the region.

APC, the civil society partner, helped the researchers to embed the method in a broad land conflict analysis. This partnership will be further deepened in the ARES project.

The researchers are targeting different audiences. First, the researchers have made a significant effort to make their research results available to a broad public by publishing – alongside specialised academic journals – in freely accessible journals targeting academics, policymakers, opinion formers and civil society actors in the Great Lakes Region. The senior researcher has recently become a co-editor of one of those journals (*Conjonctures Congolaises*). Second, they aim to target policymakers more directly (future stage) through active advocacy. The ARES project aims to target provincial authorities (South Kivu), customary authorities, and international donors. Conferences with this core group were organised in Bukavu in May 2014 and in September 2016. The team is also working on collaboration with the local media. The local communities involved in the research will benefit from the setting up of a youth theatre group that receives long-term coaching from the civil society partner (foreseen in ARES project).

The discussions launched through the Land Rush Theatre method invite people to reflect on possible solutions to land conflicts. Through such dynamics, the project aims to contribute to local community building. The researchers have transformed some of the research results into a MOOC on natural resources and development (Louv4x, EdX), reaching out to students worldwide. There are also scholarships allowing African students to participate in the MSc program at Louvain. One of this year's Congolese Master's students will receive a Ph.D scholarship through the ARES project.

Throughout the project, communication with target groups has taken place through the presence of the researchers in the field during pilot test phases. Both the theatre groups and populations involved, as well as the civil society partners, have nevertheless expressed the need for a longer-term commitment. For this reason, the researchers elaborated a project (ARES) to engage in more structural collaboration with local academic and civil society partners.

The senior researcher has created an atmosphere – and set up some structures – that continuously stimulate the team to debate on ethical reflections. There are no taboo topics and no hierarchies in these structures, and the senior researcher makes use of the team for her own ethical reflections. This will help to gain confidence and trust in a context characterised by violence and deeply rooted conflicts.

EVALUATION AND DISSEMINATION ●●●

The research is carried out by a relative small group of mainly young academics from both North and South involving partners from Université Catholique de Louvain, UCB, and ISDR. The methodology developed is unique and can be replicated in other countries facing a rush for land. A better understanding of the hidden dynamics of land conflict – before they burst out into violence – is useful in the elaboration of better land conflict management policies. The team lists ten papers in peer-reviewed ISI journals, twenty-five in other peer-reviewed journals, eighteen in in peer-reviewed books and four general books.

4.11. MedtecHTA

Project	MedtecHTA – Methods for Health Technology Assessment of Medical Devices: A European Perspective
Organisation	Università Commerciale Luigi Bocconi
Research location	Milan, Italy
Cooperation partners	Hamburg Centre for Health Economics of the University of Hamburg; University of York Centre for Health Economics; Technology Assessment Group of the Peninsula College of Medicine & Dentistry University of Exeter; Institute of Public Health, Medical Decision Making and Health Technology Assessment of the University for Health Sciences, Medical Informatics and Technology in Austria; the Institute for Economic Research in Slovenia and the European Society of Cardiology of the European Heart Rhythm Association in France
Team	One director, one deputy director, one scientific advisor, one product manager in addition to five Bocconi researchers and several researchers from the partners' institutions
Funding sources	European Union FP7 grant agreement HEALTH-F3-2012-305694
Website	www.unibocconi.it

ORGANISATIONAL BACKGROUND ●●●

The research project is led by Rosanna Tarricone from the Bocconi University. She is Associate Professor and Director of CERGAS (Centre for Research on Health and Social care Management) at Bocconi University. Five research fellows from Bocconi University are involved. A full professor and three research fellows from the group of Centre of Health Economics from York University are also consortium members. From Hamburg Centre for Health Economics there is a full professor, three research fellows and the director of the programme on Economic Evaluation and Health Technology. At the University of Exeter Medical School two researchers are involved including one full professor, one full professor and two researchers from UMIT in Austria, two researchers from the Institute for Economic Research, Ljubljana in Slovenia and three researchers from the European Society of Cardiology.

FUNDING ●●●

Funding for the research comes from the European Union Seventh Framework Programme under grant agreement HEALTH-F3-2012-305694.

PROBLEM BEING ADDRESSED ●●●

MedtecHTA aims to improve the existing methodological framework within the paradigm of Health Technology Assessment (HTA) for the assessment of medical devices and to develop this framework into a tool that provides structured, evidence-based input into health policies. Medical devices are different from drugs but are currently assessed using the same methods. This poses a risk to decision-makers and they may generate biased recommendations preventing patients from accessing cost-effective procedures.

The objective of MedtecHTA project was to investigate improvements in HTA methods to allow for more comprehensive economic evaluation of medical devices. It consisted of seven work packages (WPs) that investigated: the regulatory process of MDs in Europe and its impacts on the diffusion of medical devices; current methods used in HTA for medical devices and whether these are different from other technologies; comparative effectiveness of medical devices; value of information and the characterisation of uncertainty surrounding the development of new devices and the drivers of diffusion of medical devices.

RESEARCH DESIGN AND SOLUTION ●●●

The research team has involved several stakeholders at various stages in the research. From the very beginning an Advisory Board has helped to shape the entire project's methods and aims, and throughout the three-year study duration preliminary findings were discussed with different target audiences such as patient organisations, scientific communities, policymakers, payers, regulatory authorities and the industry. The continuous and open exchange of views and perspectives has greatly helped to improve the project and more importantly, to make its findings relevant and useful for society as a whole.

Assessment of MDs is more challenging than that of drugs in several respects: they are often diagnostic tools (e.g. multiple indications, value of information); the performance of MDs often depends on end-users (learning effect); and experimental studies (e.g. RCTs) are often unethical, difficult, or impossible to conduct. Although these challenges are widely recognised, regulatory and HTA bodies do not consider them when assessing MDs.

GRAND CHALLENGE BEING ADDRESSED ●●●

Technological innovation in healthcare is one of the key determinants of better health outcomes but also a driver of healthcare expenditure. Among health technologies, medical devices (MDs) represent a very dynamic sector which is advancing at a fast pace. Governments struggle to maintain a fair balance between patients' access to modern care and economic sustainability of healthcare systems and in doing so they endeavour to select the most cost-effective devices at the lowest possible price. Moreover, the recent economic crisis has threatened the health of people who are less advantaged. This has happened partly because governments were not equipped with the most appropriate tools to assess the inequality of access facing patients. The present research investigates the drivers of diffusion and how these can be managed in order to reduce inequalities across and within European countries and appropriate methods developed to make the right choices in the best interests of patients.

Health Technology Assessment (HTA) is undoubtedly playing an increasing role in decision-making on the introduction and diffusion of technological innovation in healthcare with the aim of balancing access to innovation and cost containment. HTA is "a multidisciplinary field of policy analysis which studies the medical, social, ethical, and economic implications of the development, diffusion, and use of health technology" and is traditionally conceived as an effective approach to guide the decision-making process for the allocation of scarce resources. Nevertheless HTA has been developed with pharmaceuticals in mind.

It has been claimed that HTA for devices raises special challenges which require the HTA community to reflect on whether the current methods adequately take account of their specific features. Two major salient features of devices deserve special attention: the device-operator interaction that can generate learning curve effects and therefore risks the presence of bias in estimating the size of the benefits and the incremental nature of innovation (e.g. longer battery life, improvements in software systems, smaller size) that needs to be addressed by adequate and reasonable licensing procedures, but also by careful identification of alternatives for comparative and incremental cost-effectiveness analysis.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

Besides academics, MedtecHTA has involved relevant stakeholders: clinicians, policymakers, providers, regulators and the industry. These actors have different backgrounds and different objectives, sometimes with opposing goals. Given the ultimate aim of MedtecHTA (i.e. to recommend a methodological framework to assess medical devices), it was fundamental to gather stakeholders' opinions to ensure that all possible aspects that might impact the way in which MDs are assessed are taken into account. The rationale is that research can translate into policy action only if shared and agreed by relevant stakeholders. The stakeholders were involved at several points during the study period. Regulators and policymakers were interviewed several times in order to elicit their preferences in terms of process and procedures for assessing MDs but also to understand their difficulties and perplexities. Clinicians have been part of a large European survey aimed at investigating the key motivational factors that predict diffusion of MDs and equality of access for patients. Hospitals have been compared to measure their performance in providing MDs and identify key success factors. The industry has been consulted in order to fully understand how MDs are developed and the challenges in carrying out clinical studies.

Target groups were involved in the research project from the start of MedtecHTA through an Advisory Board, composed of people from industry, policymakers, the scientific community, EUnetHTA and clinicians. The objectives and methods were shared with them and feedback was gathered in order to better shape the research proposal and improve the methods and materials. A website was developed on which key milestones were posted and circulated via a newsletter sent to all subscribers. Preliminary results have been presented as soon as they were ready to several conferences and workshops covering different target groups (e.g. HTAi which is widely attended by regulators, policy-makers and payers; iHEA at which academics are well represented; ISPOR with a strong industry presence; HAS-Haute Autorité de la Santé which is attended by many patients' organisations, industry, regulators and payers). The final results were presented to a large audience consisting of patients, clinicians, payers, hospital managers and the industry and discussed with HTA Agencies, Scientific Associations, the Department of Health and EunetHTA.

The MedtecHTA project made a substantial contribution towards the development of HTA methodologies and practices for medical devices for a wide range of key stakeholders and towards informing policy in the European Union, which in turn will impact on public health in the Region. The objective of the MedtecHTA project was to bring the research to the attention of various target audiences interested in methodological developments in health technology assessment: these include researchers, policymakers, the industry, and patients' associations. It aimed to demonstrate the ways in which research is contributing to a European 'Innovation Union' and to show its openness. This was done by providing tangible proof that collaborative research adds value by showing how European collaboration has achieved more than would have otherwise been possible in helping to solve the challenges facing society.

EVALUATION AND DISSEMINATION ●●●

The research originates from a paper by Drummond, Tarricone and Torbica from 2013, entitled "Alternative approaches for assessing the socioeconomic benefits of medical devices: a systematic review", published in the journal *Value in Health* (16,1: S7-S13). The article raised the issue that new approaches are needed to access the benefits of devices. This article initiated the project and on the basis of the project, the research team refers to eight journal articles since 2013. Two important changes have been accomplished. First, the results on comparative effectiveness (i.e. bias adjustment, use of real-world evidence) have been incorporated in the recommendations made by EunetHTA, the European network of HTA Agencies. Second, the Italian government has decided to constitute a National Plan for HTA in relation to MDs, with a process and methods that are differentiated from those used for drugs.

4.12. miCROWDscopy

Project	miCROWDscopy: Video games and mobile microscopes for collective telediagnosis of global health diseases
Organisation	MalariaSpot – Biomedical Image Technologies – Technical University of Madrid
Research location	Madrid, Spain
Cooperation partners	Ashoka, National Centre of Microbiology, Clinical Hospital San Carlos, Global Health Institute of Barcelona, Health Investigation Centre of Manhiça (Mozambique), National Institute for Communicable Diseases (South Africa), Technical University of Cataluña and University of Gothenburg (Sweden)
Team	The founder, two full-time researchers (software developer and communications manager), three Master's student internships and collaborators
Funding sources	National research grants and donations
Website	http://malariaspot.org and two smartphone apps

ORGANISATIONAL BACKGROUND ●●●

This project develops collective tele-diagnosis systems to empower citizens to collaborate in solving global health challenges. It is based on a crowd-computing platform, which analyses medical images taken by a microscope embedded in a smartphone connected to the internet, using image processing and human crowdsourcing through online video games. This system will provide remote, rapid, ubiquitous and accurate diagnosis of global health diseases such as malaria or tuberculosis, which are responsible for the deaths of millions of people. At the moment, it is a functional prototype that has been tested in Africa on a number of real digitalised blood samples. In the future it should work in real time in medical diagnosis. The aim is to functionally make use of collective wisdom/intelligence in society in an engaging way, using big data science to contribute to global health. In short, the idea is to develop an app embedded in the medical system.

The multidisciplinary nature of the project at the crossroads of medicine, video games, artificial intelligence and education involves a diverse range of stakeholders. The research team has several target groups and all of them are essential: medical specialists, players, developers and makers. Following the diverse stakeholders, the researchers can address the specific sensitivities due to the multicultural nature of the project, tailoring the message to each discipline and cultural context.

The underlying idea of the model is to translate medical protocols into digital micro-tasks that can be packaged into video games and performed by citizens around the world. MalariaSpot has been recognised worldwide as a pioneer and has already been the inspiration to other experiments such as screening for ocular pathologies and gamifying radiotherapy for cancer. All in all, the team relies on the belief that learning through games can be revolutionary in democratising access to universal health coverage: digital collaboration is a precious cognitive resource for solving humanity's challenges.

FUNDING ●●○

Over the past four years a number of research grants and donations have been obtained, allowing the maintenance of a staff of two, internships, travel and software/hardware resources. At present, however, the team is struggling to find sustainable funding. Many collaborators also contribute voluntarily and/or as part of their job.

PROBLEM BEING ADDRESSED ●●●

This project intends to initiate the era of crowd diagnostics by connecting a global network of mobile microscopes and citizen diagnosers. The research team is designing open-source crowd-computing tools for image analysis and an open 3D-printed microscope-in-a-smart-phone, which are extremely portable and low-cost, tailored to different global health pathologies. The practical implementation of the project is to develop a low-cost solution which is able to provide rapid and accurate diagnosis of malaria and tuberculosis, leveraging crowd computing, mobile microscopy and the efforts of global citizen diagnosers: non-medical specialists connected to the internet contributing to the diagnosis while playing a game. Such a solution can help to provide access to a diagnosis in rural areas where appropriate facilities and capacities are not available, uncovering the burden of the disease and permitting optimisation of treatments and eradication programs. Players of all ages will learn and become part of a global task force of disease hunters.

The idea behind the project was initiated in 2012, starting from the combined perspectives of global health problems, the potential of big data and the fact that everyone has a mobile device (i.e. the collective power of society using the device) to help diagnose diseases (initially malaria and now also tuberculosis). At first the project team started with a pilot game (shooting malaria parasites in pictures) using images of real blood samples. With the idea of collaborative intelligence, a team of doctors and medical specialists from South Africa and programmers in Spain were involved in developing the prototype. Very quickly 10,000 people began playing it in over hundred countries. Interestingly, the gamers were as good at spotting malaria as professional microscopy specialists.

RESEARCH DESIGN AND SOLUTION ●●●

The principal idea behind the project is that small diseases that fly under the radar, in terms of scientific interest, can be investigated using public effort (e.g. in games), as can diseases that exist on a mass scale. It relies on mass image processing supported by the public. In future, e.g. in 2020, the majority of Africa will probably be connected to the Internet, allowing for fast diagnosis. In future this should work as follows: a blood sample is taken in a health clinic and transformed locally into an image, which is uploaded, checked very quickly through the game by a large community of gamers (minutes-hours), and then reported. This target should be achievable in 2020. The mobile microscope is not yet available, but it probably will be within three years from now. The team expects the system to allow diagnosis in rural locations where appropriate facilities and capacities do not exist, permitting optimisation of treatments and eradication programs. The premise is that only a small percentage of the time people spend playing video games can already greatly contribute to providing access to diagnosis anywhere in the world. At the same time, gamers will learn about global health, and become part of a global task force of 'disease hunters'.

Research so far has shown that based on information from some twenty non-expert players, it is possible to conduct a malaria image analysis as well as an expert microscopist. The same methodology is currently also being used for tuberculosis. A few months ago, a prototype of the real time technology was tested and a field test was carried out in Mozambique. Support from the virtual community is key, not only to achieve the first real-time collective telediagnosis in history, but also to provide feedback that has been used to adapt and improve the system.

GRAND CHALLENGE BEING ADDRESSED ●●●

The main challenge concerns global health. Each year, over half a million deaths and more than 200 million new cases of malaria are identified, and about 1.5 million deaths and 9 million new cases of tuberculosis. This is despite the fact that both are curable diseases. According to the WHO, 40% of suspected malaria cases and 48% of TB cases are not diagnosed by any method. Access to diagnosis is key to the eradication of global diseases which cause millions of deaths each year and has a huge impact on development in low-income countries. However, the new generations that have grown up in the digital era are not fully aware of this problem – we spend millions of hours playing video games with poor social and learning value. We need to find a way to leverage this potential to turn a problem into a solution. The team believes diagnosis could be democratised, while at the same time facilitating learning through games can be a revolution to achieve universal health coverage. Both mass-scale and rare diseases can be collectively diagnosed with the help of citizens, freeing medical specialists to spend more time on patient treatment, conducting research or other critical tasks.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The main aim is to develop a medical diagnosis protocol that can be digitalised and which makes use of the collective intelligence and capabilities of the public. Digital literacy is increasing exponentially and represents a precious cognitive resource for solving humanity's challenges – multiplying the workforce devoted to image diagnosis – and, perhaps even helping to create new digital jobs as "telediagnosers".

The rationale behind the games is based on an open-source platform (instead of patenting the ideas) to enable collaboration with different parties. The team believes in providing open tools so anyone can adapt them to solve new problems. The outcome of the research is not patented, because one of the aims is make the knowledge available to be replicated by other teams, in other countries and in other fields. The mobile microscope design is also open source.

RRI concepts are the pillars of the project. For example, the team aims to democratise access to health diagnostics. This is part of the mission of the team, i.e. to create a benefit for society. The same is true for openness and inclusion work is not done in isolation but openly (mobilising society and scientists) and in an open source, multidisciplinary, inclusive format. Stakeholders in the areas of AI, the medical community, civil society, education and institutions can all contribute.

Partners are engaged in various ways:

- Through extensive community management: online newsletters, public lectures, other outreach in (social) media. Different layers of engagement (remotely interested vs. very engaged). Initiative also comes from the other partners, and the team is always open to ideas from others. Sometimes more offers are provided than the team can handle.

- Hackathons: competition between hackers is good to motivate good people to test the safety and possibilities of the system on an AI level. These are people who are good at software engineering outside the academic sphere. The aim is to help the research team to look for better software and hardware.

- The game is also given to high schools, which can create for example a competitive championship. In this way, citizens are learning to diagnose and become aware of global health problems.

The team uses a dynamic, iterative development process where each iteration (e.g. a new version of the game, a new digitisation protocol or a citizen engagement strategy) is evaluated by the different stakeholders, allowing to adapt and change practices in response to their feedback. From the medical perspective, the project is focused on strengthening individual, organisational and institutional capacities so that people can use innovative ICTs to address global health needs. For that purpose, the project also includes the participation of relevant African stakeholders in innovation and end-user community representatives to ensure its clinical validation.

EVALUATION AND DISSEMINATION ●●●

The research team has developed a multidisciplinary project at the crossroads of medicine, video games, artificial intelligence and education. It is well embedded with a large and diverse range of stakeholders, some of whom are contributing voluntarily. So far more than 100,000 people from 130 countries have contributed to the project. Clinical validation of the system and creation of a sustainable business model is expected by 2018. Reports have been published in various peer-reviewed publications, but also in media output, social media, newspapers etc. The research team has given public lectures in Spain and received invitations from around the world (US, France, etc.). At the moment there are two games, which make up different parts of the diagnosis protocol for malaria identification. These games address micro parts of the diagnosis system, that can be played and carried out by the gamers, and they can be accessed and downloaded via the website.

4.13. Sensory Assistive Technologies for Impaired Persons

Project	Sensory Assistive Technologies for Impaired Persons
Organisation	Robotics, Brain and Cognitive Sciences department of the Fondazione Istituto Italiano di Tecnologia
Research location	Genova, Italy
Cooperation partners	Ten partners are involved from a variety of countries, see Organisational background section
Team	A senior researcher, three postdocs, four Ph.D students, three part-time technicians
Funding sources	Fondazione Istituto Italiano di Tecnologia (www.iit.it) European Commission (ec.europa.eu) Ligurian Region (www.regione.liguria.it) Fondazione Vodafone Italia (www.vodafone.it)
Website	https: //www.iit.it/people/luca-brayda

ORGANISATIONAL BACKGROUND ●●●

The project team is led by Dr. Luca Brayda from the Department of Robotics, Brain and Cognitive Sciences of the Fondazione Istituto Italiano di Tecnologia in Genoa, Italy. The team consists of a senior researcher, three postdocs, four Ph.D students, three part-time technicians (engineers, electronic and mechanical designers) all from the same department and a Master's student from Facoltà di Scienze della Mente, University of Turin, Italy.

The project involves collaboration with 10 partners:

1. Director of the Childhood unit at the Istituto David Chiossone onlus, Genoa, Italy

2. Professor, Head of the Microsystems for Space Technologies Lab, at the Ecole Polytechnique Fédérale de Lausanne, Neuchâtel, Switzerland

3. Director of the private company Geomobile GmbH, Dortmund, Germany (software design)

4. Operational Director at Ateknea solutions, Budapest, Hungary (Design and building of custom electronics to power tactile stimulators)

5. Director of Fundacja Instytut Rozwoju Regionalnego, Krakow, Poland (contact with end-users and their families, recruitment of blind and visually impaired persons, co-design of experimental protocols)

6. Former Director of Clinical Neurophysiology from Neuroscience, Rehabilitation, Ophthalmology, Genetics and Childhood Sciences dept. of the University of Genoa, Italy (Co-design of experimental protocols and methods to assess spatial abilities)

7. Researcher at Istituto di Bioimmagini e Fisiologia Molecolare, Consiglio Nazionale delle Ricerche, Genoa, Italy (Analysis of neurophysiological data, dissemination)

8. Researcher from Dipartimento di Ingegneria dell'Informazione, University of Padua, Italy (Co-design of experimental protocols for sonification of virtual objects)

9. Engineer at Linear Srl, Genoa, Italy (contact with hearing impaired persons, building and testing of hearing aids)

10. Professor from Department of Naval, Electrical, Electronic and Telecommunications Engineering of the University of Genoa, Italy (Design of sound-filtering algorithms for GLASSENSE)

FUNDING ●●●

The BlindPAD project was funded by the European Commission under the FP7 programme.

The TActile MOuse project was funded by Fondazione Istituto Italiano di Tecnologia and co-funded by Fondazione Vodafone Italia under the Digital For Social funding programme.

The Glassense project was funded by the Ligurian Region (Italy) under the five-year development funding programme.
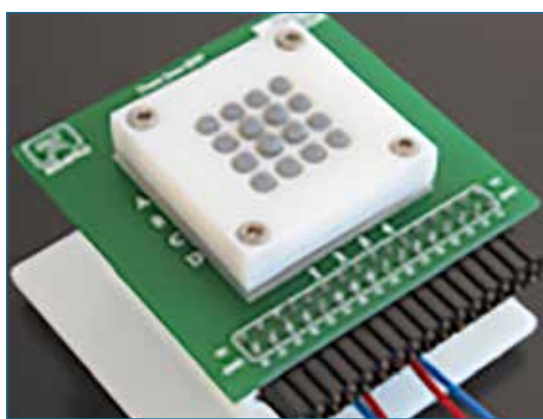
PROBLEM BEING ADDRESSED ●●●

The goal of the research project is to narrow the gap between people with disabilities in society and access to environmental information. This goal is addressed in two steps: first the focus is on understanding the best ways to exploit the residual sensory abilities of impaired individuals; second, these abilities are enhanced by building and field-testing three novel sensory assistive aids. The specific targets are on visual and acoustic impairments. Digital content is being increasingly conveyed visually, which is a serious issue for people with vision loss. Therefore the study is about ways of translating visual information into tactile content through the phenomenon of sensory substitution. The team is developing multiple prototypes: the BLINDPAD, a tactile tablet, and the TAMO, a tactile mouse for blind people. These products are meant to support the acquisition of digital content, mathematics and maps. Another product is the GLASSENSE, a novel pair of intelligent glasses, which is an aid intended to complement hearing prostheses. The prototypes are being validated in a rehabilitation setup with target groups. These products will aid understanding of how the brains of sensory-impaired individuals can effectively acquire spatial information from residual sensory channels.

RESEARCH DESIGN AND SOLUTION ●●●

The research team is investigating how sensory-deprived people compensate for missing sensory channels by vicarious modalities. In the case of visual impairment, the research addresses new ways of exploiting the sense of touch to help blind and visually impaired persons to learn scientific content, access digital information and navigate in unknown environments. In the case of hearing impairment, the research approach is based on novel ways of presenting sound to hearing-impaired persons and increasing their spatial awareness. The ultimate goal is to build low-cost solutions to narrow the digital divide, therefore increasing social inclusion.
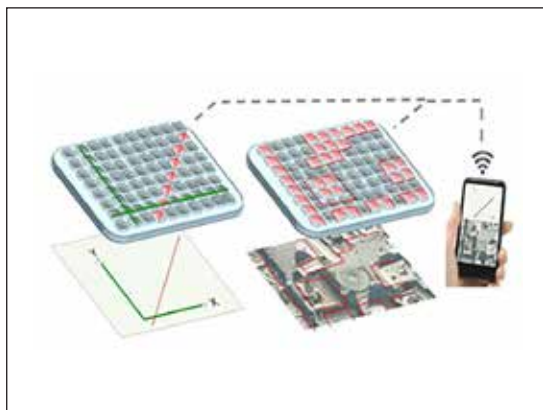
The GLASSENSE, the 'acoustic lens' for people with hearing impairment

Concept and prototype of BLINDPAD (Personal Assistive Device for BLIND and visually impaired people)

The TActile Mouse for blind people

GRAND CHALLENGE BEING ADDRESSED ●●●

By improving access to digital and environmental information, the research empowers disabled persons by offering them new possibilities. The main societal challenge is to reduce unemployment among individuals with visual and hearing impairments by improving their communication abilities, their mobility and their overall quality of life. European countries and their welfare and educational systems have divergent ways of rehabilitating visual loss, none of which are pushing towards technologies enabling independence and self-rehabilitation. This divergence is mainly due to the lack of accessible technologies, not to the lack of capacity among disabled people: the brain can adapt to new sensory conditions but this cannot occur when information is not accessible. For example, tactile maps and diagrams are bulky, expensive and not tailored to user needs. The use of the internet without sight is very difficult. For people with impairments, social exclusion results from the consequent lack of communication and mobility. Expensive hearing aids worsen the brain's ability to discriminate speech in noisy environments and there is still no solution to the further deterioration in the socialisation capabilities of both young and older people.

Although the present research helps to train the brain in alternative ways, the technologies are not prostheses, but non-invasive assistive tools. These are seen as useful tools or serious games, not as therapies. The research team is specifically targeting social communication based on the tactile tablet and a tactile mouse, which can be used with millions of web pages and social network profiles. For visually impaired persons, independent access to digital

information is crucial during childhood (when developing logical-mathematical knowledge), at developmental age (the internet is pervasive in communications between young people) and during adulthood (visual impairment correlates with high unemployment rates). When hearing impairment occurs, the products can help the brain to process speech in crowded environments, thereby preventing social isolation. Disabled persons who are more communicative, less isolated and more active will dramatically reduce welfare costs.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The researchers have developed strong links with societal actors, i.e. rehabilitation practitioners, teachers and families of end users. The assessment of the Tactile Mouse and the prototypes of BlindPAD have been monitored by stakeholders and policymakers (e.g. Institute Chiossone Onlus and Fundacja Instytut Rozwoju Regionalnego for blind subjects). The prototypes were tested using serious games that were co-designed and validated by school educators and rehabilitation practitioners. Based on the interaction with these stakeholders, the team was able to develop experimental protocols and share these between partners through a cloud-based platform. The results were disseminated to citizens throughout society in exhibitions centred on disability and the technologies were shared and developed with industrial partners that can exploit them in their product portfolios. There were contacts with these user groups and stakeholders throughout the project and during testing of the products.

The team involved three groups: children aged 6-12 years, young people aged 13-18 and adults aged over 18. The three groups were addressed with specific serious games, each designed and targeted to suit their age, spatial abilities and previous training. People with mild or no disabilities were recruited as control groups. The whole sample is replicated in two European countries: the research is multi-centric, with multiple European rehabilitation institutes contributing their different practices. This leads to considerable mutual enrichment, which is unique in the research context and very rarely done in clinical settings. The team shares research goals, experimental setups and findings with rehabilitation institutes for visually impaired people, experts in hearing impairment and centres building hearing aids. Rehabilitation practitioners co-create inclusion criteria, are constantly present during experiments and offer clinical perspectives. Based on the findings, the team has developed assistive aids with hardware and software companies which will help to make the products marketable in future.

Alongside scientific partners, the team included four main stakeholders: target groups, their families, rehabilitation centres and schools. Dissemination at exhibitions dedicated to sensory impairment ensures continuous feedback from potential future customers, thereby reducing risks.

The novel ways of stimulating the senses of touch and hearing of disabled people, as well as the three novel products, were unknown to traditional practitioners. Regular communication and meetings convinced practitioners to go beyond daily procedures and not only to try out the new techniques, but to actively participate in evaluating them. Although scientists and rehabilitation practitioners seem to speak different languages, what motivated the joint effort is the common goal shared by the research team and stakeholders which is to improve the quality of life of people with sensory losses.

The project methodology is to offer tools that do not replace but complement rehabilitation practices, which are not altered. The research is therefore synergistic with rehabilitation and represents a bottom-up process: experimental data and feedback from target groups are used to improve the type and amount of stimulation provided by the devices. The devices are turning out to be easily accepted: this is crucial, since assistive aids frequently fail to elicit interest among

those actually using them. Results are shared with the target groups: the parents of disabled children are invited to give comments; schools regularly visit the team's research site; practitioners are participating in interpreting experimental findings; flyers, news on digital social media and on websites are all distributed and updated regularly.

The user studies show that a graphical tablet for blind persons such as BLINDPAD is a highly desired solution for displaying scientific content. The findings also show that speech sources covered by "cocktail party" noise can be identified better when wearing the GLASSENSE device.

The mid-term impact is a wider assessment of the products with the stakeholders. This research part is ongoing. The motivation stems from the need to personalise the accessible information that is displayed. The research team has shown that individuals with different etiologies and disability onsets have to be treated differently. Case-by-case personalisation of sensory stimulation is changing our way of doing research, which traditionally uses the same protocol for all subjects in an experiment. The long-term impact of this is industrialisation. Stakeholders, such as rehabilitation centres, are a key factor. If they are the first buyers of the products and training aids then the impact is very likely to be high and well understood by the target groups.

EVALUATION AND DISSEMINATION ●●●

The research is coordinated by a small group of mainly young researchers and involves collaboration with a number of other research groups and practitioner organisations. The project team disseminated its findings well to civil society and policymakers. Contacts with industry seem to be at an early stage. Upscaling of the products is included in the design and contacts are currently being made with three European countries and one developing country. In total 22 publications were provided dating since 2012. Seven publications have been published in scientific journals and fifteen in conference proceedings of which three were based on conference workshops. The journals included *International Journal of Human-Computer Studies, IEEE Transaction on Haptics* and *International Journal of Social Robotics.*

4.14. Serena

Project	Serena – Serious Game for Girls about Renewable Energy Technologies
Organisation	Bonn Science Shop (WILA Bonn), Technical University of Dresden and Game Studio the Good Evil
Cooperation partners	Realschule Neuss-Holzheim and Oberschule Johann Wolfgang von Goethe Heidenau, female gaming community
Research location	Bonn, Dresden, Köln, Germany
Team	Five researchers, two professors and two game designers
Funding sources	German Federal Ministry of Research and Education
Website	http://serena.wilabonn.de

ORGANISATIONAL BACKGROUND ●●●

Since 1984, Bonn Science Shop has been working on key social challenges. The present research project is a follow-up to the Ph.D research carried out by Pia Spangenberger. She is now collaborating with her colleague, Iken Draeger, and two other researchers (one full professor and one researcher) from the Technical University of Dresden in the field of Psychology of Learning and Instruction and three researchers (one full professor and two researchers) in Vocational Didactics from the Technical University of Dresden. A private company (the Good Evil) with two game designers is developing the game.


FUNDING ●●●

Bonn Science Shop is a non-profit organisation, working on a cost-covering but not profit-oriented basis. The institution as a whole receives no official funding. It only receives regular part-funding for its Education Centre because – according to the Landesweiterbildungsgesetz NRW (North Rhine Westphalia Land Further Education Act) – it is an accredited institution for further education and training. The Serena Project is funded by the Federal Ministry of Education and Research (BMBF).

PROBLEM BEING ADDRESSED ●●●

In Germany and other European countries only a small number of women work in technical professions. The percentage of women in technical vocational training in Germany is less than 10%. Due to the fact that women face various challenges regarding the choice of a career in a technical field including discrimination against women, lack of self-confidence in this field, less family support, minority status in a male-dominated work environment as well as societal gender role stereotypes, the percentage of women remains low. Occupational segregation matters because it is a conduit for the disadvantage facing women in the labour market and limits women´s choices, impacting their potential for financial independence across a lifetime.
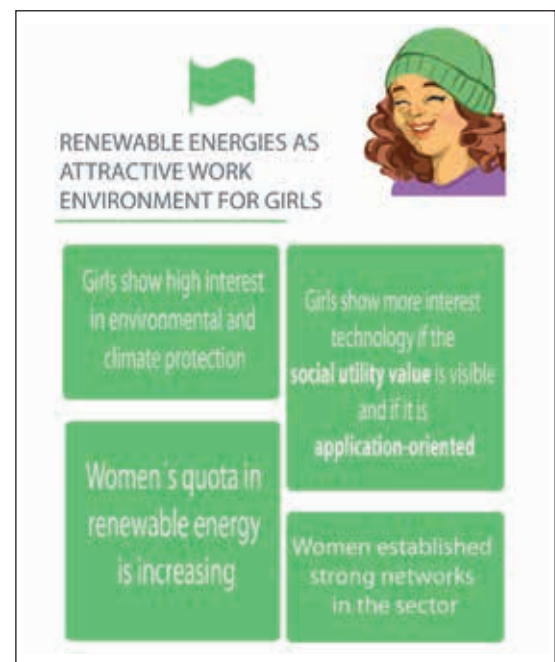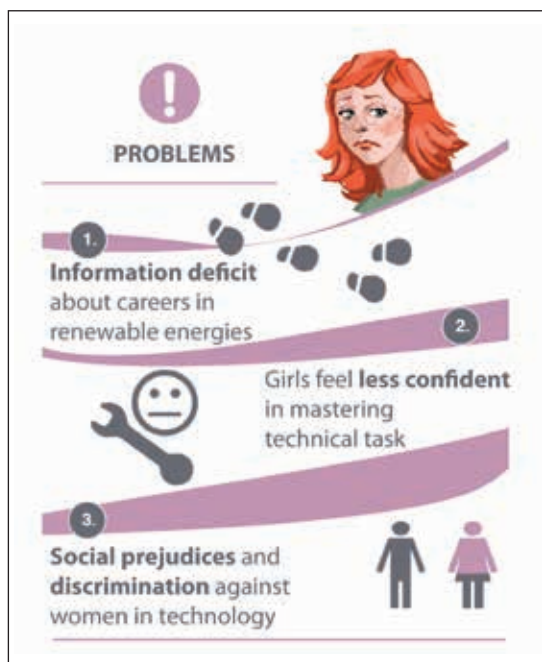
RESEARCH DESIGN AND SOLUTION ●●●

The question concerns what can promote girls´ interest in technical vocational training. Previous research has shown that the social utility value of technology can spark the interest of girls in a technical field. This needs to be illustrated and explained. Girls are also thought to care more about the environment. The Serena research project is therefore pursuing the goal of providing 13-15 year old girls with opportunities for:

- acquiring knowledge and competencies regarding technical vocations,

- mastering typical tasks and challenges in the vocational field of renewable energy technologies,

- attracting and growing girls' interest in technical vocations as well as

- developing and increasing their confidence in their technical abilities by playing a serious game.

A serious game is a computer game which communicates knowledge that isn't forced upon young people while also being playful and fun. The serious game will provide girls with opportunities to explore the exciting working areas involved in technological occupations, and in doing so, to master typical challenges facing technicians in the renewable energy sector, including

A case study collection of the European Foundations Award for Responsible Research & Innovation 2016

discrimination in a male-dominated working environment. It will also provide opportunities for identification. Players will take on the role of an avatar – a girl that lives a typical teenager's life. During her life she is confronted with technological problems which she has to solve together with her friends. The game will not be a simulation game but more of an experience game with elements of self-evaluation, which most importantly is fun to play. The method is based on the 'value expectancy model' (Eccles and Wigfield, 2002), which describes a method of stimulating self-reflection to strengthen the self-concept of one´s abilities. Game levels will start easy, with tasks such as changing a light bulb, but as the game continues these become more difficult. The design of the game addresses a number of trade-offs. The first is the balance between serious content and entertainment. What should be implemented in the game? How many objectives should be addressed? Should the game be more fun to play and not too complicated, so that it can be used in group discussions in class? The second is the balance between the level of participation and engagement versus the level of privacy. Some media are more appropriate for interaction with target groups and do not interfere with the privacy of participants (Snapchat/WhatsApp).

The final game will be evaluated to answer the research question: how can girls be attracted into technical vocational training in the field of renewable energies by playing a serious game? Design and evaluation is done in close collaboration between the Bonn Science Shop, the Technische Universität Dresden (Psychology; Vocational Education), the game studio The Good Evil and girls (aged 13 to 15) in two partner schools, using different research approaches:

- Qualitative analysis of current demands in the job market and of core competencies in the field of renewable energy professions.

- Online survey to investigate students' preferences regarding the design features of the avatars that will be implemented as player and non-player characters.

- Online survey to investigate teachers' preferences regarding usability in class.

- Development of formative and summative feedback strategies on the basis of the Interactive Tutoring Feedback model.

- Empirical evaluation study among girls to examine the effects of the feedback strategies on girls' confidence in mastering technical tasks, their interest in technical vocations and their knowledge of technical vocations.

Pedagogic concepts for teaching material will support teachers using the serious game in class. The game can be used as a tool by teachers, parents or other initiatives focusing on promoting girls' interest in technical professions. The project has both scientific and applied significance because it combines a design-based research approach to develop a serious game that aims at addressing the under-representation of female adolescents in STEM (Science, Technology, Engineering, Mathematics) through improving their confidence in mastering technical tasks.

GRAND CHALLENGE BEING ADDRESSED ●●●

Women are under-represented in technology-based occupations in Germany and other European countries. This is hardly changing in spite of a high number of initiatives to promote participation of girls in STEM occupations. Among various reasons for the lack of women in technology careers, a negative self-concept of technical abilities caused by unfavourable technical socialisation starting from birth has been identified as a major barrier hindering girls from choosing a technology career. Norms in society make it hard for girls to identify with an occupation that is not considered as feminine. Thus, the main challenges of the project are to:

- find an approach to make girls feel more self-confident about technology,

- take away the prejudices of society towards girls and technology and

- provide more information about careers for girls in renewable energies.

Since there are different types of girls and individuals may be social value or technology orientated, they have to be motivated in different ways. Their career decision-making process has to be understood to change subconscious gender role stereotypes by playing a serious game. A bottom-up approach therefore had to be developed to help girls to learn more about technology, its social utility value and how it can be used. Even once qualified, women tend not to pursue a technology career because it is a male-dominated working environment. While the game itself cannot solve that problem, it can contribute to the dialogue about discrimination against women in technology.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The Serena research project was initiated by Pia Spangenberger's thesis about women´s career choices in the wind power industry. She interviewed thirty women and men employed in the industry. The results clearly showed that sustainability has a stronger subjective significance for career choice among women than for the men who were questioned. Together with Marcus Bösch (Game Studio The Good Evil) she developed the idea of a serious game for girls using her results. Partnering with the Technische Universität Dresden, the game studio The Good Evil and two state schools the project idea received funding from the German Federal Ministry of Research and Education. At the beginning of the project a science workshop in Berlin was organised to understand main issues in this research field and involve the relevant stakeholders such as gender experts, teachers, role models and vocational didactic experts. More importantly girls (aged 13 to 15) had to be involved in development of the game. Partnering with state schools, two workshops were carried out involving 120 girls, with more to follow, to gain insights into girls' experiences, preferences and knowledge in the field of renewable energy technologies. The collaboration with girls (aged 13 to 15) ensures that the final serious game will be accepted by them.

In addition to the interaction with girls, partnering schools and gender experts, citizens in society (female adolescents, teachers, multipliers, parents) are also involved in the game's development. A monthly newsletter, Twitter, Instagram and a blog help to stay in touch with the target groups, articulate the current status of the game, research results and initial tests on the game. By playing the first test levels and participating in online surveys, girls can give feedback such as design or story preferences. The types of questions are considered carefully, so that it is not too stringent but still serious enough to generate valuable feedback. Teaching materials will help to integrate the serious game into a syllabus or free time activity. The blog also introduces professions in the renewable energy industry and role models – young women working with

renewable energy technologies. Information is available for free and can be downloaded online. Over 220 girls have already signed up as game testers on a voluntary basis and have been involved in game design through contests, workshops and surveys.

The game design also draws on information from a variety of other people through building strong networks with existing institutions in the fields of gender and STEM:

- Psychology and learning studies to process the feedback and the individual's motivation

- Sociological research results about gender role stereotypes

- Job market analysist to design realistic work environments

- Technology companies to learn more about communicating with girls as future employees. One example is Solar World (Bonn), which is providing the project with insights about everyday work experience

- Employment agencies as multipliers

- Career orientation programs in the field of gender and STEM for dissemination

- Policymakers as a final target group to make them aware of the issues described

## EVALUATION AND DISSEMINATION ●●●

A small group of young researchers are conducting the research, which is well embedded in scientific and applied communities. It combines a design-based research approach to developing a serious game that aims to address the under-representation of girls/women in STEM through improving their confidence in mastering technical tasks. The research has attracted the interest of schools and the national radio channel SWR2. Despite the small size of the group, dissemination to civil society is relatively extensive and the researchers have a strong presence in the scientific community. They have generated seven international journal publications.

4.15. Space4Agri

Project	Space4Agri (S4A): how to involve stakeholders and younger generations in Earth Observation research and support the agro-food sector in Lombardy
Organisation	Three different research institutions of the Italian National Research Council (CNR) collaborate: the Institute for Electromagnetic Sensing of the Environment (IREA), the Institute of Industrial Technologies and Automation (ITIA) and the Institute for the Dynamics of Environmental Processes (IDPA)
Research location	Milan, Italy
Cooperation partners	Collaboration with the Regione Lombardia and Arpa Lombardia
Team	Eleven senior researchers
Funding sources	IREA Funding
Website	http://space4agri.irea.cnr.it/ and a smartphone app

ORGANISATIONAL BACKGROUND ●●●

IREA-CNR is the Institute for Electromagnetic Sensing of the Environment of the National Research Council of Italy. Most of the employees have a background in natural and environmental sciences. The Institute seeks to link research to communication. RRI is a new theme in their public communication efforts. There is a small unit comprising people with a social science background who are working on communication and RRI. They aim to link the practice of communication with the theory. The unit is part of a network of people specialising in communication at other research institutes, with whom they exchange ideas. Collaboration takes place on a project basis. The organisation is structured in clusters, and the communication platform seeks to connect the different clusters. For this project, eleven senior researchers belonging to three different research institutions of CNR are collaborating. These are from IREA (six researchers) ITIA (three researchers) and IDPA (two researchers); many of these are young researchers and another six non-permanent staff have also joined the project. There is also collaboration with the Regione Lombardia. ITIA is the Institute of Industrial Technologies and Automation, which is focused on carrying out research and innovation into enabling technologies, processes and products, integrated in a factory-level framework, in order to enhance knowledge in manufacturing. IDPA is the Institute for the Dynamics of Environmental Processes and aims to
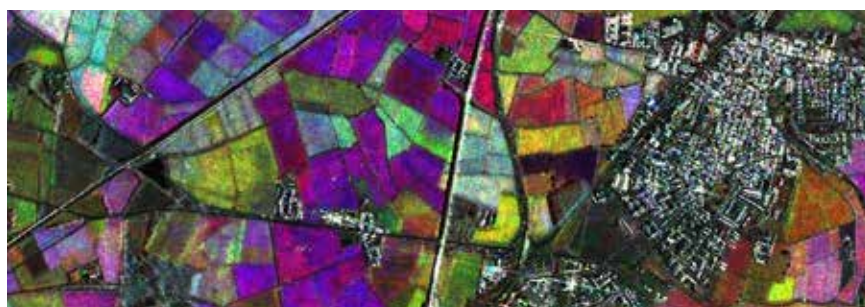
understand the "global change" of the environment and climate, on different spatial scales, its effects on the area, its evolution over time and the possible "remedies" and the influence of human behaviour. The Regione Lombardia is involved in helping further implementation among the agro-livestock in the Po Valley in Italy.

FUNDING ●●●

The main research activities were planned within the framework of the S4A work package for which a specific budget was addressed; the activities with schools had no budget and were a bottom-up initiative within the S4A project with an experimental approach.

PROBLEM BEING ADDRESSED ●●●

S4A aims to find solutions to some of Lombardy's specific needs:

- to get reliable and updated information on the agricultural system of Lombardy, such as crop mapping and monitoring of plant phenological stages, anomalies or stresses (diseases, water);

- to share such knowledge with all the actors in the agro-food chain in order to manage critical situations;

- to integrate different types of data (field, satellite observations, weather, information collected by volunteers) and make them easily accessible to public and private end-users through an interoperable spatial data infrastructure;

- to promote adoption of smart technologies and sustainable management tools by regional agricultural enterprises.

These aims required robust interaction with stakeholders and scientists. Another aim of S4A was to get younger generations interested in scientific research and promote innovation in Lombardy through educational activities involving students and professionals.

RESEARCH DESIGN AND SOLUTION ●●●

S4A uses aerospace technologies, such as satellites and drones, and ICT technologies, to help local authorities and farmers monitor and manage the agro-food sector better. S4A refers to Lombardy, the premier Italian Region for agriculture, with more than 80,000 farmers who are responsible for a large proportion of Italy's agricultural land and produce 42% of Italian rice and milk. A sub-set of these farms are involved in the Space4Agri study: their cultivation is being monitored by CNR-IREA researchers for scientific purposes and specific field measurements have been regularly taking place in the area for many years. The project adopts a multidisciplinary approach in which scientists engage with a wide range of stakeholders and sections of the public in an R&I process using satellite images, maps, drones and smart technologies.

The project is organised into three areas: Space, Aero and In-Situ ICT. Space focuses on the development of methodologies using satellite and in-situ data for mapping of crops, monitoring of their state of development and identification of possible states of stress. A series of optical and radar satellites were used to achieve this. In Aero, the DroneAGE prototype software was developed. For In-Situ ICT, the team created an interoperable spatial data infrastructure consisting of a geo-catalogue for research data and a geo-portal for viewing, return and customised
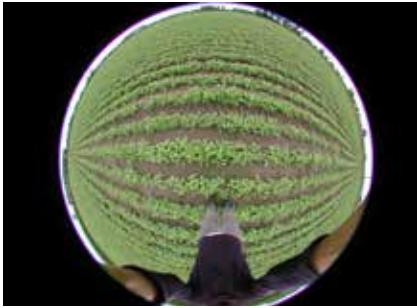
analysis of data and products (images, maps, time series of indicators) of interest to agricultural sector stakeholders (farmers and regional operators). The infrastructure is completed by Smart App S4A, available for free in the Google Play marketplace, which was developed for "smart" data collection in situ. The project was piloted during the summer cropping seasons in 2014 and 2015, in collaboration with three farms "District Lands of Lomellina" and regional operators of ARPA (Agenzia Regionale per la Protezione dell'Ambiente) and DG-Agriculture.

GRAND CHALLENGE BEING ADDRESSED ●●●

The agricultural sector is facing increasingly serious challenges due to continuing pressure from the global demand for food, and to the increase of price competition connected with the globalisation of markets and price volatility.

To meet the demand for food, the production of major cereals (maize, rice, wheat, soybeans) is expected to grow by 60% in 2050. In addition to its primary function of producing food, agriculture has further important roles: to protect the environment and the territory; to preserve biodiversity; to manage sustainable utilisation of resources and to contribute to the socio-economic survival of rural areas. The interest in sustainable agriculture combined with production output has received increasing attention from various stakeholders throughout society. The challenge is to combine the various viewpoints into a useful opportunity to understand the main challenges affecting society and the way in which science and technology can contribute towards answering them.

RESPONSIBLE RESEARCH AND INNOVATION ●●●

The research team has collected requirements from multiple stakeholders. S4A adopted an inclusive approach from the beginning of the project, involving farmers, agro-food entrepreneurs, agronomists, consultants and local authorities, making them co-design a part of the research and evaluate the main products. This procedure improved the project's socio-economic, environmental and technological impacts in terms of sustainability and acceptance.

The S4A engagement process also included science education activities that got schools and researchers involved in participative workshops during which they looked in depth at research questions such as: Can Earth Observation services support agriculture monitoring? How can a smart App be useful in an R&I project? How to prevent crop damage using modern research and technology? Students also implemented small research tasks encouraging a new form of science co-production involving Research and School. The researchers first identified the main target users and explored their "external needs". Thanks to the information provided by the respondents, a second round of more in-depth interviews was then conducted and further (new) beneficiaries were identified.

These two rounds of interviews gave the S4A researchers the chance to collect useful elements: the three domains of the Project reconstructed the state of the art based on their work, researchers gathered information on users' requirements and planned a co-designed workflow to meet the needs of the different stakeholders as far as possible.

During the research cycle, a second category of needs referred to as "internal", emerged and information on these was collected. These requirements emerging from mutual interactions between the three scientific domains revealed interesting issues relating to communication within and outside the scientific community and the perception of project co-design by all partners.

Experimentation took place on activities appealing to the younger generation through the proposal Researchers go to School (RgS): for two years 160 Lombardy high school students and ten teachers followed S4A (its steps, subjects, tools, activities) through participative work- shops. Every school, depending on its specific area of study and interests, addressed one of the thematic areas of the project. This created an opportunity for researchers to be open to the general public and experience new languages: the whole proposal brought together students, farmers and researchers' points of view. The different perspectives on science, agriculture and innovation enriched the research procedures. In the months that followed, volunteer farmers and students were selected, trained and involved in collecting field data using the S4A smart App. In particular, they involved three secondary schools in technical and agricultural aspects through a series of meetings and lectures and through active participation by students in field testing the App S4A during the 2015 season. Further follow-up is through other IREA projects and a new H2020 proposal.

The methodology followed an iterative approach and involved many interactions and feedback sessions among partners and external beneficiaries. The tools of qualitative analysis in social research were used: in-depth interviews, supported by semi-structured questions with open answers, which were processed in interpretative grids. Communication to the stakeholder groups was directly through interaction with the stakeholders involved in the research and to a wider audience mainly via the S4A website. This provides open access to publications, services (app and geoportal), resources and a network. This platform was created to engage in simple, transparent communication to all stakeholders describing the research process, its activities, tools and objectives and it was updated over the course of the project. The aim was not to merely give an account of the products and results but also to describe the ongoing research activities and field campaigns. The information presented on the project's website has also been complemented with: a calendar of project events and outreach activities such as open days, workshops, demonstrations; regular bimonthly newsletters; presentations, workshops, and speeches given by the researchers and finally multimedia materials (photographs, audio, video) concerning the research events or products. Specifically the S4A researchers produced a video manual that introduces the S4A smart App and explains its functionalities; it was shown to students and to the general public at conferences, events and demonstrations.

EVALUATION AND DISSEMINATION ●●●

The research project is well designed with various researchers from different disciplines. The research group is moderately large and is well embedded with researchers from multiple research institutions. The research approach of S4A can be replicated for other projects based on environmental operations and services to assess environmental risks or natural resources management (e.g. water monitoring, emergencies). The findings of the research are relevant to farmers' organisations, policymakers, environmental managers and will benefit citizens in general. The research team has generated 38 publications in all. These included two international journal publications in *Journal of Science Communication,* five book chapters and 31 conference proceedings.