European Cooperation in Science and Technology
- COST -
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Secretariat

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COST 4146/12

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action TD1202: Mapping and the citizen sensor

Delegations will find attached the Memorandum of Understanding for COST Action as approved by the COST Committee of Senior Officials (CSO) at its 185th meeting on 6 June 2012.

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MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action TD1202
MAPPING AND THE CITIZEN SENSOR

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to enhance the role of citizen sensing in mapping.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 60 million in 2012 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Accurate and timely maps are a fundamental resource but their production in a changing world is a major scientific and practical grand challenge. Remote sensing provides images for mapping at unparalleled rates but the ground reference data needed in map production and evaluation are difficult to acquire. The rise of citizen sensors (e.g. volunteers contributing information from remote devices) provides immense potential to radically change mapping. The quality of citizen sensor data, however, is highly variable and activity is uncoordinated. A major internationally recognised mapping challenge is how to deal with the vast amounts of image data and large bank of uncoordinated citizen sensors in a way to allow accurate mapping. This Action will evaluate the utility of citizen sensors in mapping, debate means to encourage standardisation, coordination of activity and identify how mapping can proceed with imperfect data. It will produce protocols for the collection and use of volunteered data, encouraging good practices while not constraining volunteers. The work is highly inter-disciplinary, at the interface of several COST Domains (ISCH, ICT, TUD, ESSEM, FA and FPS), and benefits from expertise distributed across Europe. The Action provides a means to foster advances mainly via networking of typically disparate groups for broad benefit.

Keywords: Mapping, volunteers, geographical information

B. BACKGROUND

B.1 General background

Maps are a fundamental resource, used for everyday activities like route planning through the legal demarcation of space to scientific studies on the design of nature reserves for species conservation. They are, for example, tools to support economic activity (e.g. location based services) and enhance human health and well-being (e.g. damage maps for disaster relief/humanitarian aid programmes).

To be of value, a map must be accurate and up-to-date. One of 11 internationally recognized grand challenges is: how to observe, analyse, and visualize a changing world? (US National Academies - www.nap.edu/catalog.php?record_id_860). The Action rises to this challenge, addressing accurate map production and evaluation with a focus on data from volunteers (citizen sensors), which is part of another of the defined scientific grand challenges. Innovatively, the Action builds on existing but uncoordinated activities by amateur and authoritative bodies deriving and/or using geographical information (GI) for topographic and thematic (e.g. land cover) mapping.

Mapping benefits from recent advances in geoinformation technologies, notably the unparalleled rate of data acquisition by remote sensing (e.g. satellite sensor imagery) and citizen sensors fostered by the proliferation of inexpensive and highly mobile location-aware devices able to provide supporting information (e.g. volunteered geographic information, orVGI, crowd-sourcing, neo-geographies and pervasive media). But the considerable potential of citizen sensing is unrealized as, paradoxically, there is now too much data and VGI is of varied quality and trust levels. Indeed the vast amount of data arising from a range of sources of differing quality is recognized as a key mapping challenge in the GI sciences.

The Action exploits the vast but largely unrealized potential of citizen sensors. It recognizes that the potential of VGI is limited by quality concerns and so focuses on flaws in VGI and means to address them. The quality of citizen sensor derived VGI is often a problem as sources range from naïve poorly trained citizens to authoritative, but imperfect, agencies as well as deliberate errors introduced maliciously. Much VGI is also collected opportunistically and spatially biased (e.g. by digital divides between urban & rural regions, developed & developing countries and amidst social classes); VGI is typically not acquired in accordance to current strict mapping specifications.

The Action shows how flaws in VGI can be addressed to aid mapping, especially that using remote sensing. A COST Action offers an ideal route forward on this important topic, acting to defragment citizen sensing activity by helping to coordinate and guide VGI collection and use. It involves and impacts on individual members of the public, academic researchers and key stakeholders such as end users. By enhancing VGI activity, the Action will add value to VGI and mapped products associated with them. Additionally, by bringing together a team from a large group of European countries and disciplines the Action encourages mobility and knowledge transfer.

The networking and capacity building opportunities offered by a COST Action allow the expertise that exists in disparate European groups to be brought together to focus on key real world scientific issues. Together the team has the ability to establish the state-of-the-art and set out how to develop future activity constructively in order to advance citizen sensing and mapping activities. The required expertise lies across traditional disciplinary boundaries, spanning the social sciences, sciences and engineering. By bringing the various groups together with a clear focus on recognised mapping challenges the Action will address important problems that will have benefits in a vast array of areas. There are networks that address component parts of the Action (e.g. authoritative map validation) but there is no network anywhere in the world that brings together the diverse communities that are central to this Action. The activity is not suited to other sources of support (e.g. it is not close to market industry-led work suitable for EUREKA).

B.2 Current state of knowledge

Mapping has a long history and 'best practices' for authoritative mapping have been established. For example, in relation to mapping from remote sensing, best practices for map validation have been defined via an expert network. The bodies engaged in authoritative mapping, however, often cannot meet the demands of the 'best practices' as common requirements (e.g. collection of data following strict probabilistic sample designs and large sample sizes for validation) are often impractical to implement and they are also typically unable to exploit the enormous potential offered by citizen sensors. Indeed, some mapping agencies see inexpensive map up-dating as a holy grail. Ways forward are either to lower standards (e.g. not evaluate map accuracy – but then the map is simply an untested hypothesis of contestable value) or, more constructively, to seek to exploit potentials such as those offered by VGI, notably by evaluating what it can and cannot be used for as well as determine the if VGI activity can be steered to be more useful.

The value of crowd sourcing has been noted in other areas (e.g. astronomy, weather and ecology). Early studies in relation to mapping, led mainly by European researchers, have also demonstrated potential roles for citizen sensors. For example, crowd-sourcing has been explored as a means of map evaluation, with web-based resources such as volunteer projects (which show ground based photographs at selected locations) used as reference data in map evaluation. Additionally, limited and imperfect reference data have been used in map production and evaluation.

For example, semi-supervised techniques using unlabeled information show a potential to derive accurate thematic maps with little reference data. Similarly, imperfect data have been used for map evaluation, with means to reducing the effect of imperfections in the reference data established. The latter includes the adoption of model-based inferential approaches as an alternative to the standard design-based inferential procedure that is the standard 'best practice', but is an approach that is alien to many in the mapping community.

The mapping problems being addressed have a long history and so are well-known but are also becoming increasingly apparent as mapping is now driven by new opportunities offered by geo-information technologies and the pace with which the mapped world is changing leads to map error and redundancy. This was highlighted recently in the vast and unparalleled response by the mapping community to post-earthquake disaster relief activity in Haiti. In this, the huge amount of well-intentioned activity by various bodies produced maps depicting different, even contradictory, information that actually hindered relief activity and yields a recognised mapping challenge. The Action rises to the challenge and is innovative in linking disparate communities. Specifically, the Action addresses key science challenges and exploits the recently created potential of citizen sensors. It gives a degree of coordination to existing activities in public (e.g. collaborative web-based volunteer projects), research (e.g. Universities), commercial/operational (e.g. mapping agencies), and voluntary/charitable (e.g. disaster) sectors. It bridges the amateur and professional worlds and straddles a set of disciplines (e.g. geography, computer science, engineering, statistics). It will show the applicability, value and limitations of VGI for map production and map evaluation activities. Unlike some crowd-sourcing projects, the Action recognises the distinction between passive and active volunteering and hence the potential to steer citizen sensing in constructive ways.

B.3 Reasons for the Action

The Action is modelled on a successful 'community service' activity of the expert network that produced the best practices in (authoritative) map accuracy assessment based on coordination of activity funded/supported nationally. The latter activity was based on a series of meetings held in different countries at which a diverse group of experts were brought together to focus on specific issues. The Action is, therefore, building on a proven approach and provides an opportunity for Europe to take a leading role on an important topic. The Action links the diverse strengths that exist across Europe in its public e.g. volunteer projects, research (e.g. Universities), commercial/operational (e.g. mapping agencies), and voluntary/charitable (e.g. disaster) sectors. The existing activity of many groups and researchers is noted and seen as a platform upon which the Action seeks to enhance activity as well as avoid duplication. The key enhancement to activity is made by providing a more coordinated approach to citizen sensing, providing awareness of the limitations and opportunities for using VGI in mapping, and forming structures for interchange between those involved (e.g. internet resources for advice, documents and links) as well as ensure that a new generation of researchers able to operate effectively in a multi-disciplinary subject is developed.

The main objectives of the Action are to review the current status of VGI in mapping activity, evaluate the strengths and limitations of VGI for key tasks in mapping and add value to VGI by indicating its quality and steering activity in constructive ways; see section C for more detail.

The expected results of the Action are diverse. Through networking events the Action: (i) brings together diverse communities to evaluate the status of VGI for mapping, (ii) defines best and good practices in VGI collection and use as well as encourage activities that do not constrain embryonic and altruistic contributions from volunteers but lead to greater consistency and inter-compatibility with other data sets to add value to VGI activities and (iii) engages citizens intimately in science by involving amateurs in activity that has hitherto been the exclusive realm of authoritative bodies such as national mapping agencies leading to more directed and coordinated VGI activity, enhanced knowledge and understanding of citizens who themselves will have enriched knowledge of science and their contribution to it.

The core focus of the Action is to advance science and technology in relation to citizen sensing and mapping. However, in doing so, the Action will also build capacity, notably in enhancing the community of young researchers, and facilitate mobility and knowledge exchange within Europe for broader scientific and social benefit. As the Action is focused on the science and technology of citizen sensors in mapping applications the main means to achieve the objectives focus on standard academic practices, notably: networking meetings/workshops, Short-term Scientific Missions (STSM), publication and dissemination to key target audiences using a variety of media to ensure appropriate communication of activity and outcomes.

The Action lies at the interface of several COST Domains (ISCH, ICT, TUD, ESSEM, FA and FPS) and so it is trans-disciplinary in nature. Its activity benefits from the different contributions and perspectives that can be offered from different disciplines and research cultures. As the latter rarely overlap and engage directly, the Action provides an ideal means for knowledge transfer and focused development on the topic by enabling better integration of separate activity at a national scale. For example, social scientists familiar with VGI data collection may be able to offer insights to volunteer motivations and potential to encourage the adoption of recommended good practices but may not have the technical skills to explore the impacts of imperfect data on mapping applications and define the tolerances of methods to error and uncertainty in way that researchers in computer science and geography can do. As well as bringing different disciplines together the Action also brings the amateur and authoritative communities together in a mutually beneficial way.

B.4 Complementarity with other research programmes

There is no similar activity elsewhere in Europe or beyond. Networks of experts in authoritative mapping , remote sensing data quality , crowd-sourcing and national mapping agencies exist as do relevant subject associations but there is no formalised activity to bring the disparate communities together on the topic of this Action. The existing expertise is fragmented and inefficiently utilised. The Action will involve and indeed encourage contributions from these various expert groups as this can act to enhance activity as well as a two-way exchange of ideas, methods and staff for mutual benefit; the Action's team includes senior representatives of relevant networks/associations. Once established, the Action will welcome additional contributors, including new and unanticipated inputs that may require an alteration in plans but which constructively contribute to fulfilling the overall aims.

C. OBJECTIVES AND BENEFITS

C.1 Aim

The aim of the Action is to enhance the role of citizen sensing in mapping.

C.2 Objectives

The Action seeks to increase the value of volunteered data provided by citizen sensors for mapping applications, with a particular focus on map production and map evaluation.
The core aim of the Action is to enhance the value of citizen sensors in mapping applications. To do this the Action will (i) help coordinate the activities of citizen sensors with particular regard to VGI data collection and dissemination, (ii) review the current status of VGI data in mapping, As well as clarifying the state-of-the-art, this activity will highlight strengths/opportunities of VGI data in addition to limitations/areas that need development for future research activity, and (iii) from (ii) define protocols to help guide the producers and users of VGI data. Arising from this activity a series of outcomes are anticipated with key deliverables including:

1. State-of-the-art summary of VGI in mapping – focused on data quality, dissemination and current utility for mapping applications. This will form the basis of a major review paper in a peer reviewed journal.
2. Enhanced coordination of VGI activity – outputs range from basic guidance notes on an internet site to directed sensing activities.
3. Recommendations on how to influence the behaviour of citizen sensors and encourage collection of valuable VGI, summarised in popular/professional and academic papers.
4. Protocols for enhanced data collection and description, disseminated via a series of suitable publications targeted to different audiences.
5. Protocols for data storage and dissemination, disseminated by a range of publication routes.
6. Survey of methods to address data quality issues in mapping, summarised in a series of academic papers.

7. Documents outlining the best and good (acceptable) practices for VGI use in map production and evaluation, disseminated in a variety of ways targeted to specific audiences.
8. An enriched community in which the role of volunteers is recognised and appreciated as well as an enrichment of the volunteers themselves through close integration with science.
9. Expansion of the community engaged constructively in mapping, from individual members of the public to academic researchers; with an emphasis on developing young researchers.

Note the aim is often to define both best and good practices, recognising that volunteers are giving their time freely and may be able/willing to follow good/acceptable practices but not necessarily the best practices. In this way the Action seeks not to constrain volunteers but to enhance the potential value of their data as well as leaving room for unplanned, serendipitous, outcomes that may arise from the flexibility provided.

C.3 How networking within the Action will yield the objectives?

The means to achieve the objectives are focused on networking and interaction between researchers with different but complementary expertise. The Action itself is modelled on a successful 'community service' organised through an expert network that focused on the development of 'best practices' in authoritative mapping from satellite remote sensor data. The Action will strive to link together the existing centres of expertise operating in relevant areas but rarely overlapping.

Networking events such as workshops are well-suited to the activity and result in enhanced knowledge transfer. The proposed STSMs also facilitate development on specific issues of concern to the Action as well as encourage mobility. The STSMs are focused on Early Stage Researchers (ESRs) and so also allow junior researchers the opportunity to work with a leading expert to advance a specific issue of concern to the Action as well as develop skills that will aid the individual's progression to that of an independent researcher. Presently researchers from 15 COST countries have joined the Action and others are welcome.

C.4 Potential impact of the Action

Beyond the immediate benefits of networking, the Action's outcomes will enhance map production and use. The Action will help coordinate and strengthen activity on this important priority topic (see section B.1) that is central to major mapping challenges and greatly contribute to more efficient use of national research funding. Given the vast array of map users and producers the Action's impacts will be felt in numerous areas and ways. For example, scientific and societal beneficiaries include:

- All connected with the environmental and political priority topic of climate change (e.g. maps of forest type and cover are required to estimate deforestation),
- The disaster relief community (e.g. >2000 VGI maps of Haiti produced in 75 days from disaster but of variable quality – which/how to use?),
- Those concerned with the conservation and sustainability of biological resources (e.g. land cover change is the greatest threat to biodiversity and hence accurate maps are needed to inform conservation).
- Epidemiology and health care provision will be enhanced as they need accurate spatial data.
- The general population as, for example, the location of croplands and management of water supplies are critical in food security.
- Those concerned with map production and evaluation such as academic researchers, the geoinformation-based industries and mapping bodies such as national mapping agencies.

The Action also impacts on individuals and voluntary groups (e.g. contributors to internet activities such as collaborative volunteer projects) especially in their relationship with science. The Action straddles the amateur and professional communities, recognising the potential for mutual benefit.

Due to the diversity of map users and the unrestricted nature of citizen sensors (open to all irrespective of age, gender, religion, race etc) the influence, impact and benefits of the Action are broad, enriching science and the public understanding of science. Indeed the unrestricted nature of volunteering should help ensure that the Action can contribute to addressing imbalances in the composition of contributors to science (e.g. gender imbalance). In knowledge-based democratic societies this engages citizens in data collection, science and ultimately in policy making and evaluation. It may also enhance the collection and verification of European statistical data.

C.5 Target groups/end users

The topic is broad in nature, interacting with a variety of communities and subjects. Innovatively, the Action is enhancing the role of volunteers as a source of critical data for mapping, building on the vast but uncoordinated potential of recent geoinformation technology developments. The Action can build on existing expertise and facilities, drawing on the strengths of organisations already active in VGI data collection to understand the role of VGI in mapping and set an agenda for the future. To achieve this, the Action must communicate with all involved, from amateurs to professionals and across disciplinary boundaries.

The results of the Action are targeted to a diverse audience. The latter ranges from individual members of the general public engaged with an activity such as the various web-based volunteer projects as a hobby, through individuals and groups contributing to charitable actions such as disaster relief activities, through to academic researchers, industry and official mapping agencies.

The diversity of potential end users is reflected in the team that has put forward the Action, with inputs from people who have acted as individual volunteers, academic researchers and mapping agencies; academic researchers from a variety of different disciplines are the main drivers of the Action and comprise ESRs and a mixture of junior and senior scientists.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The key research tasks to be coordinated by the Action are linked directly to the proposed objectives and target deliverables identified in section C.2. These tasks will invariably require inputs from specific expert groups to drive the work and so will be led by focused Working Groups (WGs) of the Action, although typically involving inter-change with other parts of the Action. While details may change as the Action evolves, the key tasks are:

1. Review the current status of citizen sensors in map production and evaluation. This backward looking activity will set the scene and form the foundations for the Action. The review will include an appraisal of the key characteristics (positive and negative) of VGI arising from citizen sensors. This will be one of the first key activities of the Action and will be led by WG1 but involve all. The outcome of this work will form the review central to deliverable 1 noted in section C.2 above.
2. Review the characteristics of volunteers and volunteer groups with particular focus on their motivation and potential to be steered to collect data suited to mapping applications. This work will be led by WG2 and will draw on the review noted in 1 but also involve inputs from volunteers and voluntary groups. The outcomes of this work will feed into deliverables 2-4, 8 and 9 defined in section C.2.
3. Drawing on the review noted in 1 above, characterise the positive aspects of VGI (e.g. geographical spread, sample size etc) and identify map production and evaluation activities that can use VGI. This work will require the specification of data needs for map production and evaluation. This will address issues such as the spatial and temporal dimensions of data collection, the precision of data collection, the tolerance of mapping methods to errors of varying type and magnitude and the needs of end users (e.g. national mapping agencies). This work will be led by WG3 (map production) and WG4 (map evaluation). It requires input from end users in terms of defining the data needs and evaluation of how existing citizen sensor data sets can be usefully employed. This work will evolve with inter-change with WG2. The outcomes of this work feed into deliverables 3-9 defined in section C.2.

4. Drawing on the review in 1 above, identify the major limitations of current VGI activity. Attention will be focused on concerns that are open to solution (e.g. by ensuring data are acquired in a particular way and documented in a standardised fashion) which could be exploited by active or steered citizen sensing activity. This work will be led by WG3 and WG4 but involve considerable interaction with WG2 to bring in the volunteer's perspective. The work is expected to advance iteratively with inputs from WG1 and WG2. The outcomes of this work will feed into deliverables 2-9 defined in section C.2.
5. Encourage networking, discussion and debate as well as focused STSM as the main means to achieve the Action's goals.

Linked to the above are a set of outputs, notably protocol statements and a series of papers in academic, popular and professional journals. It is anticipated that over the course of the Action many of these will be 'living' documents, constantly being up-dated and refined as the Action progresses but providing a basis to support activity. The preparation of draft documents will be used as milestones, timetabled to fit with the schedule of meetings, and will inform activity with the final Action publication providing its definitive statements as well as summarise the outcomes.

D.2 Scientific work plan methods and means

Using VGI requires an understanding of its nature, especially its imperfections, to allow recommendations for future activity to be made to add value to mapping programmes and so allow rapid and inexpensive map updating and evaluation. The scientific programme is best explained in relation to proposed Working Groups (WGs) but, as noted above, open to change if new contributors bring new substantive directions and content into consideration:

WG1 - Acquiring and managing VGI: The core goal of WG1 is to provide a sound understanding of current practices involving the acquisition, description, storage and distribution of VGI arising from citizen sensors. It will characterise key issues such as: the nature of VGI data sources, the expertise and training of citizen sensors, the mechanisms by which VGI is made available, what meta-data is available and if any quality control has been undertaken. This basic knowledge forms the basis on which many of the Action's activities will be built. The issues to be revisited periodically after interaction with other WGs.

Initial work reviews the current status of VGI data collection, storage and dissemination; feeding into WG3 and WG4. The group will consider a range of major issues such as the use of volunteered photography (e.g. from web-based volunteer projects), the accuracy of labelling by volunteers and consider meta-data reporting and needs (e.g. dates and orientation of photographs, importance of scale, potential of smart-phone apps etc.). A review paper will be produced to document this state-of-the-art and form the basis for debate with WG2 on how to add value to VGI by encouraging certain behaviours. This latter work will overlap with some activities of WG2, especially in relation to addressing ethical and legal issues on the use of volunteered data. Methods of making VGI available and how to foster a greater degree of consistency and standardisation without constraining individuals will also be debated with WG2. Legal and ethical issues, data collection over digital divides, data management and dissemination become the core focus of WG1 from year 2.

Milestones to help achieve the WG1's objectives are:

- To collect information on current major sources of VGI of value to mapping activities.
- To characterise the nature of the available VGI resources, identifying especially best, good and bad practices.
- To study the impact of digital divides on VGI data, notably on data quantity and quality.
- To study the suitability of VGI sources for map production and map evaluation applications (linked directly to activities in WG3 and WG4).
- To review and appraise data management and dissemination practices, including issues of inter-operability.
- To propose potential best/good practices to encourage (links to active citizen sensing, WG2).

Deliverables from WG1 include:

- A state-of-the-art review of the current status of VGI arising from citizen sensors for map production and map evaluation applications.
- A better understanding of data management and dissemination practices.
- Proposals on legal and ethical data acquisition to feed into WG2 and ultimately statements on good practice protocols with WG2, WG3 and WG4.

WG2 - Understanding and influencing contributors: The main objective of WG2 is to develop an understanding of volunteers, as individuals and in organised groups, in order to understand volunteers and their motivations which in turn may be used to promote active citizen sensing activity that is focused/steered to meet specific needs of the mapping community.

WG2 seeks to understand the motivations of citizen sensors, evaluate the strengths and limitations of different groups and networks, and use this to identify ways to encourage particular behaviours as well as recruit new contributors. A core focus is increasing the engagement of citizens in science, to appreciate their role and value, some in conjunction with WG1. Critically, this will include defining means to directly engage with and involve citizen sensors in the Action and more broadly. A key issue to be addressed by this group is the ethical dimension to the use of citizen sensing. In relation to this it should be noted that a variety of ethics policies exist. Since the COST Action does not fund research directly, ethical approvals are not required for the activities of the COST Action. However, it is important that the discussions and proposals are embedded within an appropriate research context to ensure that they have practical value.

Milestones defined to aid the WG2 in achieving its objectives are:

- To review the nature of citizen sensors providing VGI in order to better understand them and the potential to promote active VGI steered to the provision of useful data for mapping.
- To identify effective methods to engage with volunteers and voluntary bodies providing citizen sensor data.
- To review the ethical issues associated with the use of volunteers in mapping activities.
- To propose means to encourage best and/or good practices.
- To propose means to recognise, reward and incentivise citizen sensors.
- To identify, explore and develop effective means of communication with volunteers.

Deliverables derived from WG2 include:

- Strategies to encourage the adoption of best and/or good practices that inform key protocol documentation.
- A mechanism to engage citizen sensors directly into the Action’s activity and beyond.

- Guidance on the ethical issues linked to using volunteers in support of mapping activities.
- Contributions to protocols statements in association with the other WGs.

WG3 - Map production: The goals are to define the needs of the map producing community, identify the sensitivity and tolerance of mapping methods to different types of error and uncertainty in VGI and assess the potential role of current VGI efforts as well as of active citizen sensing.

Informed by the review of the current status from WG1 and WG2, this group will debate the potential contributions of VGI to map production. Topics covered include the ability to identify and remove potentially erroneous data, the sensitivity of mapping methods to error and the degree of tolerance to differing types and magnitude of error and uncertainty. Arising from this debate it will be possible to identify the attributes of useable data and so define best and good practices, which can be fed back to WG1 and WG2 to determine the ability to encourage citizen sensors to acquire VGI in most useful ways.

Milestones to help achieve the WG3's objectives are:

- An understanding of the data needs (not desires) for the production of accurate maps.
- An assessment of the degree of sensitivity and tolerance of popular mapping methods to errors of differing kind and magnitude in typical mapping scenarios.
- Informed by outcomes from WG1, identification of sources of VGI that currently have value to map production.
- Propose how VGI could be enhanced via active sensing with WG2.
- Propose how the management and dissemination of VGI could be enhanced WG1.

Deliverables from WG3 are:
- An enhanced understanding of the needs of the map producing community.
- Guidance on the suitability of mapping methods to VGI of varying quality.
- Contribution to the protocol statements with other WGs.

WG4 - Map validation activities: The main goals of WG4 are to define the data needs for map evaluation, identify the sensitivity and tolerance of methods to different types of error and uncertainty in VGI and assess the potential role of current VGI efforts as well as active sensing.

Using the current status of VGI report arising from WG1 and WG2 this group will evaluate the suitability of VGI for map accuracy assessment. Key concerns relate to the quality of the VGI and their spatial location in relation to requirements of current methods. The group will debate how VGI can be used and identify good practices to encourage which will be fed back to WG1 and WG2. WG4 and WG3 will also have some joint meetings as there may be commonalities. Both of these groups will, for example, have to consider statistical sampling design issues; though the requirements and specifics should differ between the two groups. In relation to map validation activities, it is for example, expected that one focus will be on evaluating the strengths and limitations of different sample designs (e.g. systematic sample used in some web-based volunteer projects) relative to stratified random designs used in the authoritative approach) and how to best steer citizens.

Milestones to help achieve the WG4's objectives are:

- An understanding of the data needs (not desires) for the evaluation of map accuracy.
- An assessment of the degree of sensitivity and tolerance to errors of differing kind and magnitude in typical mapping scenarios.
- Review sampling issues and the suitability of different sampling designs for credible accuracy assessment.
- Informed by outcomes from WG1, identification of the sources of VGI that currently has value to map evaluation.
- Propose how VGI could be enhanced via active sensing with WG2.
- Indicate meta-data needs to add value to VGI dissemination with WG1.

Deliverables from WG4 are:

- An enhanced understanding of the needs of the map evaluation community and how citizen sensors can help satisfy these needs.
- Guidance on the suitability of different types of VGI data to map evaluation activities.
- Contribution to the protocol statements with the other WGs.

The goals will be achieved by:
(1) a series of meetings, notably meetings of the Management Committee (MC) with associated meetings of the WGs. The timing of meetings will be linked for efficiencies in time and resources with family-friendly policies used in scheduling events (e.g. child-care issues/school holidays to be considered). Attendance comprises Action's members together with experts from outside Europe and open to new Action participants; some responding to open calls for subsidized attendance (targeted mainly at early career, female, and the volunteer community) as appropriate. Some meetings will be linked to other events (e.g. conferences) to facilitate attendance, logistics and encourage contributions from others interested in the Action. Effort will be made to involve volunteers; indeed a goal of WG2 is to determine and use an effective means of communication with the volunteer community. It is anticipated that the latter will involve contributions from those linked to web-based resources to represent their community as well as contributions from the general public. Given the nature of the citizen sensors (they could be of any age, nationality etc) it is likely that many contributions from the volunteers directly will be made through web-based systems and possibly Skype/web-conference facilities although at least one meeting will coincide with an event targeted at the volunteer community to obtain their active involvement in the project.

(2) a programme of STSMs, allowing ESRs to work with senior researchers in other institutions for ~2 weeks to ~3 months. Places filled by open competition with applications evaluated by a sub-group of the main Management Committee. This will form an international young research community that can advance future research (e.g. via Horizon 2012). The potential to enhance gender balance and build capacity will form part of the assessment of bids for STSMs.

(3) Support for conference attendance (targeted at ESRs presenting oral papers).

E. ORGANISATION

E.1 Coordination and organisation

The Action will be operated in accordance to the 'Rules and Procedures for Implementing COST Actions'. Thus, the Management Committee will have the overall responsibility for the supervision and coordination of the Action. The Management Committee will undertake all the normal activities such as: appointment of Action Chair, Action Vice-Chair and WG coordinators; plan Management Committee meetings; develop and assess progress reports from WGs as part of monitoring activity and to ensure progression in relation to the Action's objectives using appropriate milestones; promote, monitor and appraise STSMs; promote interaction and knowledge exchange between WGs; prepare annual reports; establish and maintain a web site for communication and dissemination etc.

Given the Management Committee's oversight role no deviation from the normal COST procedures is anticipated but named individual members of the Management Committee will hold key roles:

- An Early-Stage Researcher officer/representative - to ensure that ESRs are involved at all levels of the project and form an effective think tank. This individual will suggest topics for Early-Stage Researcher events (e.g. on writing for journal publication – where senior staff with journal editing experience could help junior colleagues develop important skills required in the transition to independent research leaders of the future), encourage reverse mentoring opportunities (in which junior colleagues help more senior ones unfamiliar with recent technological advances) and promote social activities.
- An equal opportunities officer – to promote a more equal gender balance, assist with issues such as the specification and adoption of family-friendly policies.
- An 'external view/liaison' officer – to monitor related activity, especially that outside the European Research Area, and up-date the Management Committee on key trends and activities with the aim of enhancing benefit and avoiding duplication. This role holder will be the key link to external groups etc.

The above roles are not meant to be onerous and do not involve an abdication of responsibility which remains with the Management Committee and its key members but rather acts as a mechanism to ensure that the Management Committee does not overlook important issues and to aid effective activity by having a specified individual with the role in their portfolio. Role holders will be members of the Management Committee and the Action aims to make these roles attractive to early stage researchers and so provide one means to further integrate them into the Action in a manner that also allows individual creativity and effort to flourish to aid personal development.

With the proposed structure, the meetings would be:

- 2 meetings of the Management Committee each year.
- 2 meetings of each WG each year, some to be joint reflecting inter-dependencies.
- An average of 1 Core Group (Management Committee chair and vice-chair, WG coordinators) meeting every second year.
- 1 Early Stage Researcher event per year.
- These meetings would be supplemented by an average of 4 STSM per-year.

As far as possible, the meetings will be linked to other events such as major international conferences. This should facilitate attendance, with attendees able to combine the Action meetings with another activity and so use time and resources efficiently; this has been proved to be an effective way of ensuring attendance and efficient use of limited time and budgets available in other contexts. In defining the exact details, the requirement to follow family-friendly policies will be strictly adhered to (e.g. impact of school holidays/child care needs to be addressed in the planning of all meetings with preference given to dates that work best for typically disadvantaged groups such as female colleagues with family commitments). There is a variety of societies/organisations that hold major conferences focused on geographical information and remote sensing as well as particular application areas such as in relation to disasters , or, say, forest resources . Ideally meetings will be staged in a variety of the countries participating in the Action.

E.2 Working Groups

As defined in section D, the Action will establish four inter-dependent WGs to develop focused activity:

- WG1 - Acquiring and managing VGI.
- WG2 - Understanding and influencing contributors.
- WG3 - Map production.
- WG4 - Map validation activities.

The WGs are to be encouraged to interact and indeed many of the milestones and deliverables require inputs from more than one WG (see section D) with progress to the final outcome being a process of iteration with the outcomes of one WGs activity informing the work of others.

The WGs will have two co-ordinators; leading female researchers and early stage researchers will be encouraged to take on co-ordination roles to enhance their representation and contribution to the Action. The WGs will coordinate activity within their scope and communicate with all others. The WG will promote STSM, especially inter-WG activity to further strengthen the links between the WGs. Membership of the WGs will be open to allow multiple memberships and monitored annually by Management Committee with particular regard to gender balance and ESRs.

It is possible that the Action could expand in unanticipated ways that might see need for additional Working Groups (e.g. a new cross-cutting theme on blending authoritative and volunteer activity or perhaps a more focused application orientated activity addressing a particular domain (e.g. hazard mapping, forestry etc) or a grouping focused on the exploitation of new technologies).

E.3 Liaison and interaction with other research programmes

The importance of other research programmes is recognised and the specification of an 'external view/liaison officer' in section E.1 is designed to help ensure that the Action is aware of and responsive to relevant work beyond its immediate scope. To further aid this and ensure that the Action is also communicating its work to other relevant groups, it should be noted that the Action's membership includes senior representatives from major relevant subject associations, researchers involved with other programmes as well as high level involvement from industry and national mapping agencies.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas.

Recognising the current composition of the Action, activities such as the approval of STSMs will include gender balance in the making of decisions. Additionally, female scientists and early stage researchers will also be encouraged to chair (or co-chair if highly inexperienced and likely to benefit from close mentor support) WGs and to lead (co-lead) on major activities such as workshop organisation and dissemination activities. The suggested roles in Section E.1 also represent small, manageable, but important roles that develop skills and networks; capacity-building is seen as a fundamental part of this Action and will be a consideration throughout its period of existence. The proposed equal opportunities officer (section E.1) will help the Action achieve a more equitable balance in its activity.

F. TIMETABLE

Activity	Yr 1				Yr 2				Yr 3				Yr 4			
MC meeting	x		x		x		x		x		x		x			x
STSM		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
WG1			x		x		x		x		x		x		x	
WG2			x		x		x		x		x		x		x	
WG3			x		x		x		x		x		x		x	
WG4			x		x		x		x		x		x		x	
Final Publication																x
Web site		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Depending on the circumstances, there may be a Kick-Off meeting prior to the first formal Management Committee meeting. It is also anticipated that there will be 2 Core Group meetings (chair and vice-chairs of the Management Committee and WG coordinators), probably in years 2 and 3 to help maintain focus on the Action's objectives and ensure that the main Action activities and programme of meetings are well-planned. These Core Group meetings may be needed to help ensure that the necessary flows of information between WGs occurs and within required timeframes. In many ways these meetings are designed to help address unanticipated opportunities and/or problems and so their timing cannot be specified in the timetable above.

Management Committee and WG meetings will last ~2-3 days and at least one dedicated ESR event will be held each year. The scheduling of meetings will be linked to international conferences and requirements of family-friendly policies. Management Committee meetings will include formal administrative management meeting activities (e.g. monitoring of progress to milestones and goals, publications, presentations, assessment of new and inter-disciplinary networking, gender composition etc) and scientific workshops to which will be linked WG meetings.

G. ECONOMIC DIMENSION

The following COST Countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CH, DE, EL, ES, FR, IE, IS, IT, NL, NO, PT, SK, UK. On the basis of the national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 60 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries above but no other countries will participate in the Action. Any departure from this will change the total accordingly.

H. DISSEMINATION PLAN

H.1 Who?

Because of the diversity of the Action members and the target audience, the Action's results will be disseminated widely. The target audience can mostly be grouped into three classes:

(i) individual volunteers – typically members of the general public who volunteer, perhaps via organised activities (e.g. web-based volunteer projects) and charitable bodies.
(ii) academic researchers – in a wide range of disciplines (e.g. the team proposing the Action includes geographers, computer scientists, foresters, statisticians, engineers etc.).
(iii) professional bodies involved in mapping – typically national mapping agencies but also commercial companies.

As the Action develops, other bodies may become involved, perhaps through formally joining the Action. The Management Committee will review and modify as appropriate the Action's dissemination plan and activity to reflect any agreed changes.

H.2 What?

The key status review, the protocol statements, good/best practice documents (defined in section C.2) represent the core outputs from the Action. Outputs derived from the Action will be targeted at different communities as appropriate to their needs and interest. The final publication of the Action will contain all the outcomes and form the reference resource that is the legacy of its activity and the basis for future work exploiting opportunities such as those offered nationally and by instruments such as Horizon 2020 to enhance European competitiveness. Following the groups identified in section H.1 the main material to be disseminated is:

(i) Individuals – here the aim is to focus on providing summaries of the state-of-the-art review and key protocols for VGI collection to help steer future VGI. Additionally short articles in popular scientific and popular literature (e.g. popular magazines and professional magazines) that provide low-level summaries of the research. Those involved with running web-based resources will be included in key document circulations such as the full protocols as these are important gatekeepers to the volunteer community. Part of the material disseminated will show the value of VGI to mapping activity and so act as feedback to the citizen sensing community on its contributions.

(ii) Academic researchers – this group will be the target audience for the main review journal papers (e.g. from all of the WGs), protocol documents and good/best practice documentation. Articles will be directed to the main high-impact peer-reviewed international research journals. Given the desire to ensure broad outreach it is expected that a substantial proportion of the journal publications arising from the Action will be in widely available, open-access, form. It is likely that the activities of some WGs will be amenable to the production of a special issues of journals focused on Action related topics and this will be encouraged, especially in helping to promote the careers of early stage researchers. The final and most important outcome of the Action will be its final proceedings, which is most likely to take the form of an edited book.

(iii) Professional bodies – will be most interested in the state-of-the-art review and the protocol statements as the main material, with the academic papers as supplementary contextual information and the Action's final publication a source of key reference. Articles in professional magazines will also aid dissemination of the Action and its outputs to the professional communities involved in mapping.

H.3 How?

Because of the diversity of the Action members and the target audience, a variety of routes are planned to disseminate the work. Capturing and stimulating the target audiences will focus on:

- Web and other electronic based communication, targeting those concerned with the Action and beyond; parts may be password protected for confidentiality. The Action's dedicated web site will play a critical role in this activity and will have sections targeted to different communities and be up-dated regularly. The web page will link to associated social media sites (especially if WG2 finds these to be important communication mechanisms).
- Articles in popular magazines and brochures targeted at the general public to show the value of VGI in mapping and encourage contributions.
- Articles in peer-reviewed international scientific journals, targeting the academic researchers and authoritative mapping community.
- Articles in professional journals, targeted at those working especially in the geoinformation technologies.
- Via conference presentations and associated proceedings, targeting the different disciplinary communities involved in the Action. ESRs will be encouraged to contribute oral presentations to major international conferences to aid their personal professional development and the development of a strong young community.
- Through inclusion of Action outcomes in the teaching programmes of the Universities involved and beyond.
- Within the Action networking activity will also enhance knowledge transfer. This will be based on traditional methods (e.g. oral presentations, papers etc) but the potential for non-traditional methods such as reverse mentoring will be explored.

- The Action's main contributions will be summarised in its final publication, anticipated to be an edited book that summarises the main contributions to all target audiences and provides the legacy for the Action's work that will be a reference for future research and development. The Action's work should spur research applications (e.g. to Horizon 2020).

Note that one key objective of WG2 is to explore means to communicate with the citizen sensing community and this may add additional mechanisms (e.g. blogs, leaflets, use of social media such as Facebook and Twitter etc.) to the list above.

Management Committee will monitor publication activity on an annual basis as part of its general monitoring and evaluation activity (which will also include assessment of recent advances/breakthroughs; tangible impacts achieved; development of spin-off activity and proposals; Action membership and composition; STSMs with particular regard to cross-WG activity, composition and progress; Action events with particular regard to numbers by gender, career stage and discipline; links to relevant external activity and other Actions; as well as self-critical assessment on progress to inform future work and pro-active effort to address any concerns).

In addition to basic reporting on dissemination activities, the activities will be broken down by gender and ESR involvement to assess the Action's endeavours in developing strong and balanced

community for the future. Assessment will include appraisal of impact (e.g. adoption of protocols by organisations, citations in the literature etc.) and form part of the annual monitoring activity of the Action as impactful dissemination rather than basic publication is fundamental to advancing the subject. The Action's team includes senior editorial board members (editors-in-chief, associate editors etc) of major relevant journals and these could help advise more junior colleagues on scientific writing to ensure impactful publication rather than simple publication and aid the production of strong proposals for special issues linked to the Action's work.