Community Memories for Sustainable Societies

Luc Steels
Sony Computer Science Lab - Paris

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Abstract

Our species stands before the unprecedented challenge to fundamentally change its ways in order to avoid the potential catastrophe that would make our world inhabitable and the dangerous tensions that inevitably arise when food, energy and other resources become scarce. This paper raises the question what computer science can contribute to help foster this change. It focuses on community memories. These are distributed web-based information systems that help to raise awareness for the need of action and organise collective effort towards the fair and sustainable management of a commons. Three upcoming technologies are discussed for creating community memories: high performance volunteer computing, participatory mobile sensing, and social tagging.

1 Limits to Growth

Already in the sixties, Rachel Carson published *Silent Spring* [1], a forceful pamphlet that examined the impact of humans on the biosystem due to the use of pesticides, pollution, and badly thought out large-scale environmental changes through dams, forest clearance, etc. Even though the book was met with enormous hostility at first, it did have a serious impact on policy, such as the ban on DDT a decade later, and it stimulated the formation of the first 'green' movements in the seventies. A decade later, the Club of Rome, founded by Italian economist Aurelio Peccei, published its influential book 'Limits to Growth' [2]. It showed with actual data and computer modeling that there was no way the dominating economical system, based on constant growth and 'free' use of natural resources like air and water, could be maintained. Their message was again highly criticised and rejected by the majority of the public, policy makers and industrialists. In the eighties and nineties, all seemed forgotten and the emphasis in already developed economies was again put squarely on growth. On top of that development started to accelerate also in several very large developing nations, such as China and India, who were quickly catching up, not only for industrial production and consumption but also for the unwanted side effects like pollution and destruction of the environment. Because the signs are now everywhere, as emphasised in Al Gore's documentary 'An Inconvenient Truth', there is a renewed and rapidly spreading awareness that we are now effectively reaching the limits to growth that were predicted decades ago and that the early warnings have to be taken much more seriously. Not only are we running out of some crucial resources (some authors have argued that the peak of oil availability was in 2006 and from now there is a steep decline [3]), even more worrying, the impact of unchecked industrialisation is contributing to a fundamental change to the climate and hence the habitable ecologies and biosystems of our world [4].

Scientists and engineers bear part of the responsability for this state of affairs and it is normal that they are now expected to help find solutions, particularly if this requires new technologies: electronic devices consuming less energy, better technologies for insulating buildings, reduction of the use of precious resources in products, etc. There are clear signs that many engineers and companies are now working towards these goals. But the question is whether this is enough. Although it will become possible to construct more efficient homes, as in passive houses, if we keep building bigger buildings and the population keeps expanding so that more buildings are needed, these technologies only help to cope with ever increasing demands. It is possible to get more fuel efficiency in cars thanks to better motors, tyres, aerodynamics, etc., but if traffic keeps expanding there is no net gain. Often a 'rebound' effect occurs, because those who made savings because of increased energy efficiency spend them on something else (for example a long-distance vacation trip) which requires the energy they saved. Of course, research efforts to achieve better and more proper use of resources is necessary, but it cannot be the only course of action. It is only a fundamental change in mentality and behavior that can lead to long term sustainable solutions, and this inevitably means that humans must become much more resource aware in all their activities and that the human population explosion can be managed.

The present paper focuses on information technologies. Their massive introduction has been one of the factors that is driving globalization and hence accelerated growth, and information technologies are themselves becoming a significant factor in the increased use of energy. Many new applications using the Web, such as virtual worlds, may turn out to be in the end as unsustainable as their real world counter parts. (An avatar in Second Life requires as much electricity (1,752 kWH/year) as the average Brazilian and requires 1.17 ton of CO2! (http://www.roughtype.com/archives/2006/12/avatars_consume.php).) Of course, there is dramatic progress in the reduction of energy requirements of computers, servers, telecommunication, displays, etc., but these hardly keep up with the increased usage that is made of these technologies. And so also here we are faced with the question how we can get or contribute to a change in mentality.

2 Managing the Commons

One way to frame the many issues grouped under the header of sustainability is to view them through the lens of the management of a commons [5]. A commons is a shared 'common pool' resource. It can be as basic as water and air, but it can also be space on the road, wood in the forest, access to public spaces, bandwidth for information transmission, cultural artefacts, political opinion, reputation, etc. To have a *sustainable* commons requires first of all that a balance is maintained between input and output, which means that those who take from the commons must ensure that the processes to regenerate the commons are in place. Second, there are almost always conflicts between those that help to supply input and those that take output, and between those that take output under the condition of scarcity. The strongest form of egoism occurs with those who take whatever they want from the commons without providing input themselves, possibly using violence against other users of the commons or plain theft.

Further conflicts arise when one community that is managing a commons is confronted by outsiders or other stakeholders that feel they should have access to the same commons. For example, the same patch of forest is claimed both by logging companies (possibly given a licence by the government) and the population that actually lives in the forest, or the same low frequency band of the spectrum is claimed by WIFI networks and radio broadcasters.

Traditionally human societies manage a commons by organising themselves around communities. I do not define a community here in terms of family, ethnicity, or social strata (us against them), but rather in terms of the commons that they manage. If such management is not done right, the suffering can be immense or a destruction of the commons can be swift. It is a primary role of government to help manage the commons but sometimes governments do not have the competence nor the power to do so and new areas and issues come up all the time, so large areas of human activity are not regulated at all or need to be self-regulated [6].

Managing a commons in a self-organised way is difficult. A lot of work in biology and the social sciences [7] has shown abundantly that altruism and cooperative behavior, essential for the proper management of a commons, will only emerge and be sustainable when either the participating individuals are genetically sufficiently similar so that it is in their self-interest to help others (as in ant societies) or when there are enough checks and balances so that free riders and cheaters can be identified and punished. The latter requires at the very least individual recognition so that it is possible to monitor the reputation of others and possibly administer sanctions. Typically in most biological species, dominance hierarchies emerge, which often involve violence for their dynamic maintenance, whereas humans have managed to establish large-scale cooperative societies by instituting the rule of law, even if it is sometimes precarious [8].

Due to increasing trade, migratory movements, and instant communication, the areas and the size of the population concerned with some of our common resource pools gets larger and larger so that traditional ways for governing a commons are less and less effective. This is particularly the case for climate issues which span the whole globe and require all nations to participate. The difficulties to enact the Kyoto protocol show how hard it is. Given this importance of commons management and given that there are now many ecological, social and cultural systems under severe threat, I believe that collective tools for managing a commons should be a key new target application area for information technologies, because if a community can be created with knowledge, interest and responsability for a particular commons, that commons is on the whole automatically managed better. The needs are just as great for modern densely populated urban societies, as for indigenous semi-nomadic communities which are trying to preserve their rain forest environment against the onslaught of logging companies [9].

3 Current Information Technologies Encourage Individualism

The issue of managing the commons is also relevant in the information technology world itself and we see the same sort of problems coming up as those endangering our biosystems, ecological environments, etc. Even though it is never explicitly stated, current computer technology is strongly influenced by three factors: (1) The individual user is regarded as central. He or she acts as an individual who is working on his/her own and can get in contact with others only through a computer interface, if at all. It is true that computers are more and more networked and therefore inter-individual contact is more and more possible, but interfaces and technology limitations such as limited bandwidth, necessarily create a strong barier compared with natural interaction. (2) Technologies are designed so that the individual user can easily hide his or her identity: while sending email, being active in chat rooms or virtual worlds, submitting to blogs, even for using other person's computers. This has been a very strong rallying point on the part of the programming community in the name of freedom, but it makes it possible to hide one's intentions and avoid reponsability for individual actions.

Because human individuals interacting through the vast network of the internet do certainly not have or feel any sufficiently strong kinship relation, other means to establish cooperative behavior must be fond. The lack of fool proof individual recognition is making this impossible. Also the lack of a clear 'rule of law' and of mechanisms to enforce it quickly lead to situations where the will of the strongest dominates. The early Internet world and programming itself was strongly guided by an altruistic model of sharing, as still present in Open Source communities, the Free software movement, or the 'Creative Commons' [10]. However it has been invaded by a growing group of 'entrepreneurs' who feel no obligation to abide by this model. The negative consequences for the proper management of the information commons are now clearly visible:

- *Tragedy of the Commons.* SPAM which is a clear example of anonymous exploitation of the commons (being in this case the bandwidth, storage capacity, and time of all of us) now accounts for 90 % of all internet traffic, leading to huge extra expenses for spam filtering and useless traffic. It is sad to see that social tagging, to be discussed later in this article, is already polluted by spammers who try to get traffic to their own sites [11].

- *Mob behavior*: Increasingly incidents are reported whereby groups of individuals anonymously attack individuals or other groups through the internet. Bullying by children of their classmates or teachers through chat rooms, email and 'social' network sites (see e.g. schoolscandals.com) has taken on alarming proportions (in the UK 1 in 4 children is affected, not to speak of their teachers). These phenomena are usually started in an anonymous fashion and because of rapid positive feedback in Internet communication, mob behavior occurs and escalates. Moreover because of the long term memory in web systems, allegations, rumours and embarassing materials have a tendency to live on and propagate in uncontrolled ways [12].

- *Identity confusion*: Although a majority of users does not, there is a sufficiently large segment that deliberately hide their actions on the Internet. They take on other identities, steal identities, etc. most often with malicious intent.

- *Information manipulation*: It was only a matter of time before sites like Wikipedia would be victim to information manipulation by interested parties. Again the anonymity acts as a cover for those who want to do this. In the end it can destroy the utility and trustworthiness of these sites, in other words the creative commons of cultural goods created by others in good faith.

- *Misappropriation*: The appropriation of work or property of others is now also a routine component of the business models of Internet companies. Because there are not enough checks on exploitative behaviors, we often see that content supplied in good faith (or not even supplied) is appropriated by others for their own gain: Email addresses that are innocently given are later sold or used for entirely different purposes such as advertising or identity theft. Pictures put on photo sharing websites are later sold by galerists without the knowledge of their makers. News items written by professional journalists are diffused without any benefit to those who labored to create them.

All these phenomena are a consequence of certain fundamental design decisions made by website developers and businesses, but they have lead to unacceptable negative effects which in the end could kill the extraordinary possibilities offered by Internet technologies. Moreover one should question the morality and responsability of those creating these socially devastating instruments.

4 Community Memories

Collective Intelligence refers to a set of tools that use contemporary information and communication technologies on the one hand, but do it in a way that harnesses the activities of a large group of individuals [13] . The tools include: (1) ways of capturing some aspects of the environment in a fully distributed fashion, e.g. through pictures or sound recordings, (2) ways of uploading these data to central websites, (3) tagging these data with additional information, such as geographical location or human-observed facts or classifications, (4) finding patterns in the data using 'data mining' techniques, (5) enhancing the data with operational models that show scenarios how a situation will evolve in the future and (6) visualising and communicating the information in a way that it becomes understandable to those concerned.

Community memories use these technologies in order to build and support communities. A Community Memory is a medium for recording and archiving information relevant to a commons that is managed by a community and for diffusing this information among members or communicating it to those threatening the commons and thus the community. All members making up the community typically have access and are allowed to upload, download or inspect information. Once the information is there it becomes possible to 'add intelligence' to the system in various ways, for example by creating maps containing information in relation to its geographic location, by explicating dependencies between information items in order to bring out trends and predict future evolutions, by simulating future states of the world, etc. There have been some historical precedents for Community Memories ([14], [15]) but it is only now that the technology is available and cheap enough to put this concept into real practice [16].

'Community memories' are intended for a real community of real individuals, not a diffuse group that flock anonymously through the Internet and have no real stake in the management of a commons. This implies that there must be first and foremost a community and a commons to be managed. This community can of course take shape as part of the creation of a Community Memory or get reenforced by it, but the community will normally be relatively small. The duration of a project is typically limited in time, enough to resolve the conflicts straining the use of the commons. In order to make the community function, it is necessary that its members recognise each other as individuals and that they meet face-to-face. These meetings are necessary to create the kind of trust and common ground that is required to self-organise the group's activities. Moreover it is absolutely crucial that identity cannot be hidden and actions (even if it is simply the posting of information) can be traced back to the individuals who carried them out.

A Community Memory is therefore the opposite of a 'Smart Mob', defined as "people who are able to act in concert even if they don't know each other" [12]. With a community memory, people are assumed to act in concert because they share a common goal, which is the management of a commons in a fair and sustainable way, and as a consequence the negative side effects of collective intelligence can be avoided. The community orientation impacts all aspects; how these tools are put into practice (face-to-face contact, self steering by the group, individual recognition, etc.) and the technologies employed: the type of interfaces (usually mobile phones instead of computers), the complexity of the interface (which needs to be as simple as possible), etc. Here are two examples of community memories:

Case study 1: A Community Memory for Mbendjele Pygmies (Congo, Africa)

One of the ecosystem currently under enormous stress are the rainforests in the Congo. They contain wood of great value to logging companies but the trees may be of equally great if not more to the indigenous people who actually live and must survive in these forests, such as the Mbendjele pygmees. A tree may be important for them, for example because they are a rich source of caterpillars that is used as food, or because they stand on burial grounds and are considered to be sacred. So this is a classical example of a commons (the rain forest) with competing forces interested in exploiting it. Although the pygmies have managed the forest for centuries in a sustainable way and have their own internal systems for dividing output from the commons and making sure it can regenerate, the same interests are not shared by logging companies, who generally are after the wood without concern for sustainability or for local communities. The only force which restricts logging companies is the acquisition of a special label of the Forest Stewardship Council that attests that the wood has been harvested in a sustainable, environmentally friendly, and socially responsable way. This label may one day be obligatory and already allows a premium price for the wood in Europe.

To address the question how the pygmies, an illiterate people devoid of any prior experience with information technology, could map out knowledge about trees in the forest for themselves and for the logging companies, Jerome Lewis, an anthropologist at the London School of Economics, devised one of the most successful examples to date of a Community Memory [17]. The pygmies are semi-nomadic and there are only 3000 surviving members. They form a clear prior community living on the principle of abudance [9], meaning that they share all resources they have, so that they do not need to extract more than they need, and they restrain themselves or move to other areas when they sense that an area of forest is no longer yielding what is needed for life sustainance.

The Community Memory built by Lewis and his coworkers contains the following ingredients:

- Portable palm-pilot-style devices (see figure 1) which are available to members of the community that want to participate in the recording of knowledge.
- An iconic interface with a discrimination tree based decision system that is used to tag trees or forest areas.
- A space localisation system based on GPS that automatically supplies information about location.
- A database system for uploading and downloading information in a fully distributed fashion but not necessarily when information is being gathered in the forest.
- Geographical Information Resources, so that the information can be organised and displayed on maps, like Google maps, which are easily recognised by the community members.

Figure 1: Interface device used for the Pygmie Community Memory developed by Jerome Lewis. It aids in the management of areas in the Congo rainforest.

- An external information system to communicate crucial information to the Logging Companies which are the primary competitors for the community's commons.

The project started to log parts of the Congo basin where the Mbendjele live in 2006, first on an experimental basis and then more systematically. Information is visualised for the Mbendjele themselves through mapping software which they can easily understand. The information is relayed to the logging company involved which claims to respect the decisions of the local community and has thus managed to get the desired quality label for part of their concessions. One of the most important points is that the community is engaged and feels empowered because they themselves are able to do the monitoring, as opposed to outside experts who know little of their territories.

Case study 2: A Community Memory for Handicapped People in Barcelona

Here is another example of a community memory developed by Eugenio Tisselli (currently working at Sony CSL Paris) in collaboration with the Catalan artist Antoni Abad (see zexe.net). The description that follows is adopted from [16] which contains additional examples. The project canal*ACCESSIBLE was initiated in 2005, with the aim of enabling people on wheelchairs in Barcelona to defend their access to the commons of public spaces and streets, specifically by classifying the physical barriers that they encounter and locating them on a map. Through the use of multimedia mobile phones, the participants of canal*ACCESSIBLE could take pictures of inaccessible places and send them directly to a web server. Users indicated also the location (something which in other projects is often done automatically through GPS or newer technologies like Place Engine) and so every multimedia file could be located on a digitized map of Barcelona. After only three months, more than 3.000 inaccessible places were recorded and located on the city map and they were tagged with information relevant to accessibility. Patterns in the data could be found and displayed.

Each week, the 40 participants got together in a meeting space which was especially set up for them at the Centre d'Art Santa Mònica, an arts centre located in the heart of Barcelona and discussed different strategies for finding and publishing their images. On some occasions, they used the digitized map as a reference, and organized special trips to cover unexplored areas of the city. Thus, the map became both a record that reflected their activity and also a live Community Memory interface, which they used to decide on future actions. The discussions at the meetings also resulted in a basic classification of urban barriers. The participants categorized them as "stairs", "steps", ephemeral barriers caused by "inconsiderate" citizens (such as a parked car blocking a sidewalk), "badly adapted" infrastructures (for example, ramps steeper than the accepted maximum of 12 degrees), "transportation", "sidewalks" and "public toilets". At the end of the project, several thousands of 'non-accessibility' maps of Barcelona with colored markers that corresponded to the architectural barriers were printed and handed out to the public and the city's authorities, which felt the need to respond with their own 'accessibility' map. The community that formed through the project keeps momentum today, and a similar project is currently being launched for the city of Geneva in Switzerland.

Figure 2: The public browsing interface of canal*ACCESSIBLE. Display of an inaccessible place (in this case a truck obstructing pedestrian area) and location on the map where the problem occurs.

5 Innovative Technologies for Community Memories

Community memories require many state-of-the art technologies and they could act as a driver for additional advances in several areas of computer science and engineering. The remainder of this chapter focuses on three such innovations that are currently being explored at Sony CSL Paris. They refer to more powerful ways to add intelligence to community memories through high performance computing, better data gathering capacities through mobile sensing, and social tagging as a way to help communities develop and structure their 'conceptual spaces'.

5.1 High Performance Volunteer Computing

It is possible to simulate future trajectories of the physical and economical evolution of the environment, and these predictions can then be made visible to the public at large in order to understand the need for the fundamental mentality change that was advocated in the introduction. Indeed, if people understand how their commons is in danger they are more easily brought into collective action and are willing to identify and punish those who destroy the commons. However the quality of prediction depends on the quality of the models, and on how much computing power can be brought to bear. Moreover the simulation results are only believable and have an impact if the results can be properly visualized and if the public at large has access to them and believes that the data on which the simulations are based is credible. Volunteer computing is a novel approach to achieve both aims at once. It consists in linking large numbers of computers into grids to perform computing that would otherwise require very expensive supercomputers.

Already in 1999, Prof Myles Allen (Dept of Physics, Univ of Oxford) launched a call for 'Do-it-yourself climate prediction' in the journal Nature [18]. He argued that if the public could be encouraged to provide computing power through the personal computers they have at home and linked with the internet, then this could solve two problems: (i) vast amounts of additional computing power could become available so that it would be possible at a low cost to reach performance levels which are now only attained with supercomputers, and (ii) the public would be drawn into the process of climate prediction and thus become interested and more aware of the results.

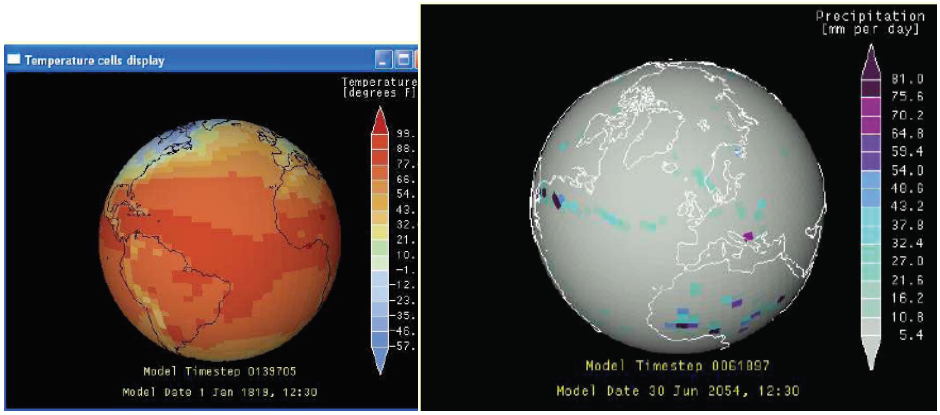

Figure 3: Climateprediction.Net user interface allowing individuals who contribute computing power to visualise the results of predictions. It shows future states of the world for temperature and precipitation.

Ten years later, this vision has been achieved [19], [20]. On the one hand, an initiative for distributed computing proposed by the Berkeley computer science department (BOINC) has made it possible to efficiently farm out computational tasks to a large group of users and integrate their results (see 'boinc.berkeley.edu'). This technology has been used as the basis for the 'climateprediction.net' initiative which allows a user to download a climate model developed by the UK Metoffice, compute one trajectory of such a model for a given period of time, and upload the result to a central server to integrate it with those of other users. In a highly visible project publicised by the BBC and started in 2006, about 100,000 users participated in the computation of various parameter variations for the standard climate model and thus add a probabilistic dimension to climate forecasting. The project ran for about a year.

At Sony CSL Paris, a group lead by Peter Hanappe is currently exploring similar ideas in order to boost the speed, accuracy, and time needed for realistic climate prediction. Instead of personal computers, the project uses the enhanced power of the Cell processor at the core of the Sony Playstation 3 as a computing engine. Obviously the technical challenges are enormous, both to port the massively complex climate simulation model to a new architecture and to make distributed computing effective for this application area. However we can foresee a future where climate models will be available to communities, both to track and predict weather patterns in their immediate environment, as well as to understand the effect of certain decisions (for example the elimination of forest area or the construction of new dams). Enhanced computation will also help to foresee the growth and effects of atmospheric pollution on the earth's climate and thus play a role in the current debates surrounding the Kyoto protocol. More generally, tools for modeling the environment and predicting the effects of change are critical ingredients to support decision making among opposing stakeholders in the management of a commons [21].

5.2 Participatory Mobile Sensing

Many low-power sensory devices now exist that can be embedded in sensor networks, typically distributed over some geographical area. A natural extension of this concept is Participatory Sensing. It "takes everyday mobile devices, such as cellular phones, to form interactive, participatory sensor networks that enable public and professional users to gather, analyze and share knowledge." [22] For example, existing mobile devices are either used as sensors directly (for example for sound), or they are extended with additional hardware in order to monitor certain environmental parameters in a location-aware way. It is obvious that such participatory sensing can be of enormous value as a component technology for community memories concerned with the environment. Current sensing of environmental pollution levels is surprising sparse, despite the obvious connection between pollution and human health (see [23] for an example study). Although there are governmental agencies that monitor air pollution (such as AirParif in Paris or the Air Quality Network in London), these agencies necessarily have to work with a limited number of sensors which are usually static and located in public spaces. To get a much more accurate picture it would be necessary to motivate much larger groups of people to engage in sensing, and also sense exposure to pollution when people are moving about or are located in private spaces like cars or homes. At the same time, the participation of individuals in sensing and access to the integrated results will help to mobilise them for environmental causes and thus make it easier to enact policies that are to some extent limiting 'personal freedom'.

Several small-scale experiments have already been performed to show the potential and importance of participatory sensing in environmental monitoring:

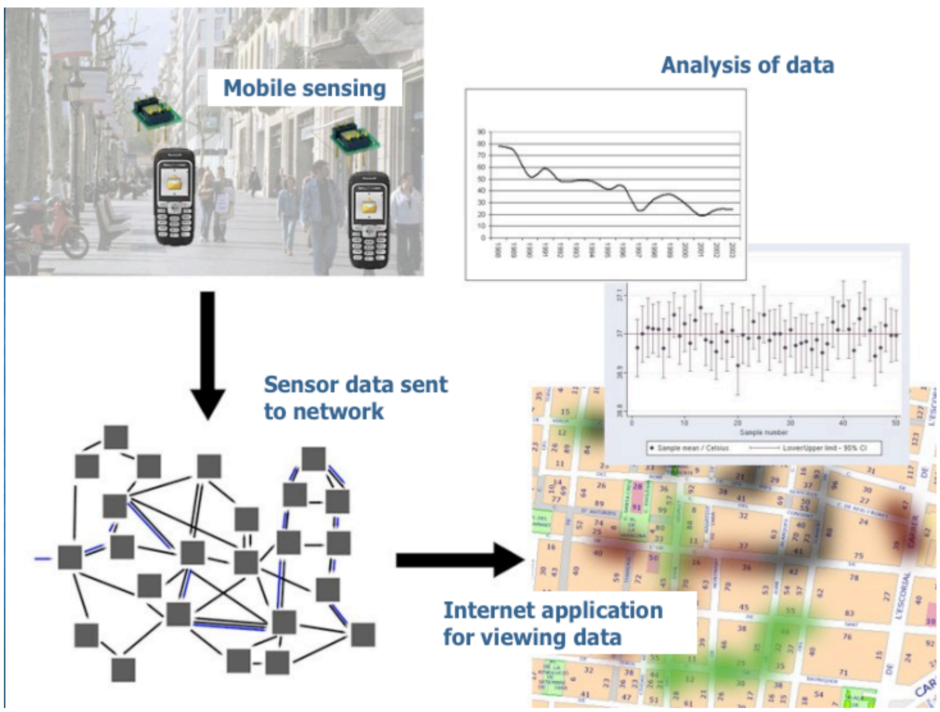

Figure 4: Overview of the technological infrastructure based on mobile phones, as used in participatory sensing projects.

- In the UK, a group of universities have created the EQUATOR project, which has realised the infrastructure shown in figure 4. It has already done a large number of studies, using pedestrians and cyclists to monitor air pollution, particularly CO, in urban environments, specifically the city of London. The data is collected through sensors carried by individuals, uploaded, and mapped out in geographical 2D and 3D images, which are available through public web sites.
  See: http://www.dapple.org.uk/

- A group from the University of Berkeley has set up the N-Smarts sensor network for environmental monitoring which includes a sensor for Carbon Monoxide and other gases, a small circuit board for logging and a mobile phone interface. The group has carried out experiments in Accra (Ghana) monitoring pollution levels in the city.
  See: http://www.cs.berkeley.edu/ honicky/nsmarts/index.shtml

- In Paris, the AirParif agence has worked with a group of 150 volunteers in order to map out personal pollution exposure in Paris in the winter and summer of 2007. They were chosen to represent the total population divided into groups including children, cyclists, car drivers, home dwellers, etc. The volunteers were given portable sensors that there were being carried for 12 hours on these two days.
  See: http://www.airparif.asso.fr/page.php?rubrique=projets&article=exposition

At Sony CSL Paris, a group lead by Eugenio Tiselli is currently further extending these ideas and technologies further in order to improve pollution monitoring. Tiselli and his team have built a prototype of a generic device that can be attached easily to mobile phones and constructed a generic 'community memory', based on the experiences with the Zexe.net projects discussed earlier. A trial experiment is currently going on in Paris, in which a group of participants can use environmental sensors connected to mobile phones to monitor aspects of their personal living space. The results are uploaded and integrated as in the other participatory sensing experiments. The project is intended to massively increase the scale at which participatory sensing becomes possible and thus develop a very fine-grained picture of pollution.

The project uses perhaps less stringent criteria from a scientific point of view than some of the others listed earlier, but it intends to make up for this by making massive amounts of data available, both by allowing 24 hour day-to-day monitoring, by integrating automated geographic localisation and tagging so that users can provide both objective and subjective meta-data, and by having automatic uploading and integration. The data is potentially available to be plugged into atmospheric or epidemiological models so that impact of pollution on health as well as evolution of pollution based on weather conditions, traffic, etc. can be modeled. As in the case of volunteer computing, the aim is not simply to improve the quality of sensing but also to motivate the public at large to get involved and thus make them aware that a fundamental change in the current societal organisation is necessary.

5.3 Social Tagging in Community Memories

Social tagging burst on the scene a few years ago through sites like CiteULike and Flickr and is now a routine component of many content provisioning and content sharing web sites. The idea of tagging is straightforward: Users associate tags (words) of their own choosing with media items like pictures, text, video, etc., and they can then browse through these items by using the tags. For any given item they see the tags and for any tag they can find back the items that have been tagged that way. Tags are then made visible to a whole group of users and frequency of occurrence as well as co-occurrence is displayed in the form of tag clouds which thus visualise the emergent 'folksonomy'. Browsing can be further enhanced by adding content processing, such as visual feature detection, or signal and text processing[24]. It is remarkable that despite the totally distributed activities of users, there are nevertheless clear trends detectable in the usage of tags [11] which is why tagging can act as a bottom-up alternative to the top-down design of ontologies practiced for the semantic web. Tagging is obviously a crucial component for community memories. It is a way in which the community can provide meta-data and information about the commons that they are concerned with. It helps to see the trends and conceptualise the difficulties they are encountering and it can help in order to find materials back.

One of the first examples exploring tagging in this respect is an ongoing community project, similar to the one in Barcelona, set up by a team lead by Antoni Abad and Eugenio Tisselli with the motoboys in Sao Paulo. Motoboys are messengers who dash across the streets of Sao Paulo on their motorcycles, delivering all sorts of things, from pizzas to confidential documents. The lack of a special lane for motorcycles, and the pressing need to rapidly complete their deliveries, forces them to drive at full speed through the narrow space

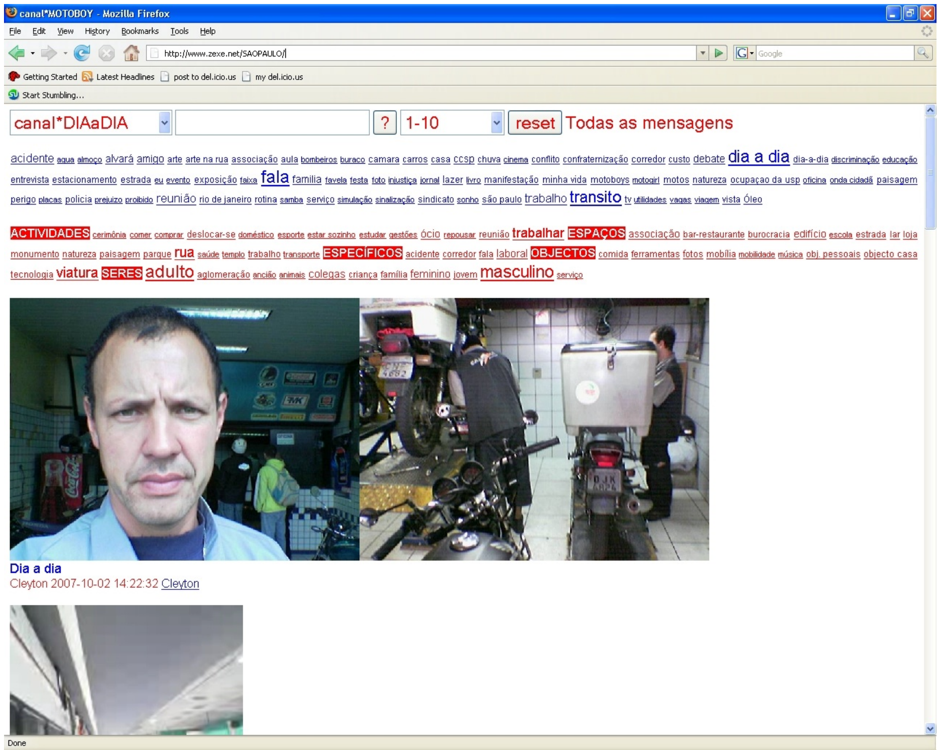

Figure 5: Web interface to the Motoboy Community Memory which shows two tag clouds, one emerging bottom-up (shown at the top) and the other one based on an organised taxonomy (shown below it). We see some uploaded images with associated information.

between road lanes. So we get another classical conflict about a commons, in this case the areas available for traffic in a city. Moreover because the motoboys have a rather bad reputation, it is an opportunity for the motoboys to fight back in the 'opinion commons' and reclaim part of their reputation. For the *Motoboy community memory, the motoboys were given multimedia mobile phones and invited to publish images, audio and video clips from the city streets to the project's web page. Crucially, all information had to be annotated using tags, which could be associated to the contents directly on the mobile phones, or by using a special web interface after the contents had been sent. The aggregation of all the motoboys' tags is shown on the main page of canal*MOTOBOY as a tag cloud, which is a list that contains the most significant tags in the annotation system (see figure 5).

As discussed in [25], there is an interesting difference between how and why tagging is use in community memories or in more traditional Web 2.0 applications such as Flickr. Community Memories are set up for another purpose than simply archiving, sharing, and retrieving media materials. The items put into the community memory are representations, in the rich semiotic sense of the term: They attempt to express meanings, i.e. aspects of interaction with the environment that are important for their makers and which they want to share with other members of the group as well as with outsiders. Tags thus become not only simple aids in future navigation but they form an intricate component in representation making. They highlight what the producer of the image believes to be the essential meanings. Psychologists consider representation-making a crucial path for self-development, because through representations the producer is stimulated to conceptualise reality and seek good ways to express that conceptualisation and thus think about how others may view the same reality [26]. Tagging goes one step further than individual expression. It can be viewed as a form of distributed cognition, similar to other cultural activities in which individuals and groups form their own identity and construct conceptual frameworks for making sense of their environment through symbols [24].

These self-representations are particularly important to intervene in the opinion commons where social reputation or social valuation of certain goods is negotiated. A beautiful pristine lake for some, is just a potential energy source for another. A dangerous level of pollution for some, is just the price to pay for individual freedom of mobility for another. A burial site for some, is just a potential road for going through with a bulldozer for another. Tagging is therefore a primary means to act upon the interpretation of the materials that make up a commons and to communicate and negotiate this interpretation. As in volunteer computing and participatory sensing, a crucial feature of tagging is that it is an activity of a group, whereby global features emerge through individual actions and no-one can control the outcome.

5.4 Conclusion

For those who care to investigate the matter, it is clear that the current organisation of our societies and economies needs to change dramatically if we want to maintain a sustainable world for the future. The issues arise at many levels, from the problems in inner cities to the stress on remote biosystems and the human influenced climate change that is affecting the whole globe. All sciences and engineering disciplines have an obligation to help turn the tide, including computer science. I focused here on community memories, information platforms that computer scientists are currently researching to manage a commons, for example the quality of the air or public spaces in a city or valuable trees or sacred spaces in the rainforest. Internet technologies and the increased power of computers have produced a wealth of possible tools for building Community Memories. I highlighted three important innovations which are currently being explored at Sony CSL Paris: High performance Volunteer Computing, Participatory Mobile Sensing, and Social Tagging. All these technologies go beyond the individualistic attitudes that underly most of today's computer technnology, in the sense that they enable and support group behavior.

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