IEEE COMMUNICATIONS SOCIETY	**TCSN Newsletter –Issue Seven– December 2021** ***Social Networks Technical Committee*** Editor: Dr. Anna Maria Vegni

TC website	https://sn.committees.comsoc.org/
TC officers	Chair: Prof. Damla Turgut
	Vice-Chair: Prof. De-Nian Yang
	Secretary: Prof. Burak Kantarci
Newsletter editor	Dr. Anna Maria Vegni

For information about the newsletter, please contact annamaria.vegni@uniroma3.it

CHAIR'S MESSAGE

When social media dominates the traffic over the Internet and mobile communication networks, there are further insights and engineering that could be developed based on understanding social networks in depth. Such interplay between technological networks and social networks has so many different aspects to inspire IEEE Communications Society members toward the further frontier of communication technology and benefits of human society. Under such background, Technical Committee on Social Networks (TCSN) is established in 2016, after incubation as a sub-committee in Emerging Technology. We believe that the TCSN newsletters allow us a more fluent exchange of vision, ideas, and technological opportunities, in addition to the website and social media platforms. We greatly appreciate all the members who have contributed to this issue of the newsletter. Last, but not least, we wish TCSN newsletters serve as an effective means for this exciting multi-disciplinary knowledge on social networks to blend humanity and technology in an even better way. Most important, please welcome you to actively participate or initiate more volunteer services to TCSN and IEEE Communications Society.

Best wishes,

Damla Turgut, Chair, TCSN, 2021-2022

UPCOMING CONFERENCES & CFP FOR SOCIAL NETWORKS TRACK

IEEE ICC 2022: May 16 – May 20, Seoul, South Korea
IEEE Globecom 2022: December 4 – December 8, Rio de Janeiro, Brazil

Social networks have become prevalent forms of communication and interaction on the Internet and contribute to an increase in network traffic. As a result, social networks have attracted significant research interests in many related areas. Social networks have traditionally been studied outside of the technological domains; however, the focus is now changing towards networking challenges such as cloud, privacy, data analytics, and so on while still keeping the social perspective such as focusing on improving quality of life. The interplay between social networks and technological networks such as mobile networks and mobile computing is becoming still strong and many areas are still to be exploited.

A SOCIAL BEHAVIORAL APPROACH TO IMPROVE ENERGY EFFICIENCY OF SMART RESIDENTIAL ENVIRONMENTS

SIMONE SILVESTRI,

ASSOCIATE PROFESSOR, DEPT. OF COMPUTER SCIENCE

UNIVERSITY OF KENTUCKY, KY, USA

DENISE A. BAKER,

ASSISTANT PROFESSOR, DEPT. OF PSYCHOLOGICAL SCIENCE

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY, MO, USA

The US Energy and Information Association reported residential energy consumption over 1.9 trillion kilowatt-hours in 2020, with a projected increase of 20% by 2050. Getting residential energy users to reduce or shift energy consumption are critical strategies to mitigating grid instability due to demand peaks. One approach that has been implemented in several parts of the US is the use of demand response (DR) systems. DR systems are mainly aimed at reducing demand peaks by incentivizing users to consumer less electricity and/or to consume it at less busy times of the day. However, the effectiveness of DR in reducing energy consumption and improving energy grid reliability is not clear. For example, research suggests that providing explicit information to users about the cost of energy use during the day can actually increase energy consumption. Just as importantly, DR can put some users at greater financial burden than others. DR systems require users to know when pricing is high, to have flexible schedules that allow for shifting daily living tasks to off peak times (often at night or on weekends), and to continuously remember to engage in high-cost avoidance behaviors. Shift workers, low information users, individuals with medical or cognitive impairments, or those who are otherwise overburdened may not have the means or ability to avoid using electricity when it is expensive. Some of these shortcomings can be addressed through thoughtful, human-centered design of smart energy management systems (SEMS). SEMS can be used with (or without) demand response systems to monitor energy consumption and perform energy conservation behaviors automatically. However, misuse and disuse are likely to occur if systems do not accurately reflect the users' personal goals and needs. Therefore, human-centered design of these systems means not only on engineering security, privacy, reliability, and interoperability, but also substantively integrates user values and needs. To achieve this latter goal a social-behavioral approach to system design is needed and, importantly, it must accommodate human values and needs when they are *situated within an entire residential environment*. That is goals, needs, and values associated with technologies are dynamic and co-constructed, often changing as a function of what is happening in the home. SEMs must be able to dynamically reflect these changes.

Internet of Things Technologies for Energy Management

A significant body of research has also highlighted that a key component to achieve user side SEM is the pervasive diffusion of Information and Communication Technologies (ICT), using novel paradigms such as the Internet of Things (IoT). Smart appliances of our everyday life, equipped with micro-controllers, transceivers, and suitable protocols to become part of the Internet, will ubiquitously proliferate in our homes, realizing the so-called Smart Residential Environments (SREs). Examples of IoT enabled smart appliances include the Nest Learning Thermostat, which adapts its setting based on house occupancy and learned user preferences. Similarly, General Electric has started a line of smart appliances, such as fridges, dishwashers, and ovens, that can be remotely controlled through WiFi. Several smart outlets have been also recently proposed. These outlets allow fine grain energy monitoring with the ability to upload energy consumption to the cloud, and provide user feedback through smart phone apps.

Although the potential of SREs is promising, previous approaches have *largely neglected* human psychological and behavioral factors that influence energy management in these environments. For example, there are several psychological phenomena that could hijack a system that takes away too much user control, regardless of the potential benefits that could result. For example, psychological reactance is a motivational state that functions to restore behavioral freedoms or autonomy that are taken away or threatened with elimination. When a persuasion attempt seeks to limit an individual's freedom, this motivational state can elicit behavioral responses that are directly counteractive. In general, users can widely differ in the way they perceive the behavior of a system and interact with it, due to differences in their personalities, education, culture, economic status, etc. Supported by recent research in the social behavioral science and electrical engineering domains that shows the importance of modeling human behavior and perception in these systems our vision is the following:

> The success of smart residential environments in improving our everyday life, while achieving desirable goals such as reducing energy consumption, can be accomplished only by interdisciplinary approaches that merge psychological models to capture holistically the complexity of human nature with computationally efficient optimization techniques.

An Interdisciplinary Approach to Energy Conservation

We propose a novel paradigm to overcome current limitations associated with state-of-the-art energy management systems that explicitly includes humans in the design loop through novel algorithmic, machine learning and optimization solutions that specifically consider user behaviors, perceptions, and psychological processes. Specifically, at the basis of our approach is modeling user perception and behaviors through *perceptional models*. As an example, these models may capture the perceived importance of home appliances and activities through several aspects of user well-being. Additionally, *behavioral models* can also be inspired by the field of Behavioral Economics, which introduces concepts such as loss aversion and bounded rationality that can also occur when a human interacts with an energy management system. These models consider the limited available information, cognitive capabilities, and time that may result in sub-optimal decision, non-rational behavior, and counter-intuitive expectations in the system operation.

The main challenge of this interdisciplinary research lies in the translation of psychological theories into system operation decisions. We believe that machine learning can play an important role into inferring and quantifying the psychological models given data collected by IoT-enriched environments. Additionally, new optimization techniques need to be defined to use the learned models and translate them into system operational actions. Overall, the long-term goal is to lay the foundations for a new field of study at the intersection of computer science and social sciences, where social-behavioral theories and models are integrated into new algorithmic, machine learning, and optimization solutions to specifically consider user behaviors, perceptions, and psychological processes in the design and operation of future energy management systems.

Simone Silvestri, silvestri@cs.uky.edu
Denise A. Baker, bakerden@mst.edu

THE DECENTRALIZATION OF ONLINE SOCIAL NETWORKS AND MEDIA

BARBARA GUIDI,

ASSISTANT PROFESSOR, DEPT. OF COMPUTER SCIENCE

UNIVERSITY OF PISA, ITALY

ANDREA MICHIENZI

POSTDOCTORAL RESEARCHER, DEPT. OF COMPUTER SCIENCE

UNIVERSITY OF PISA, ITALY

Online Social Networks (OSNs) have become one of the most popular applications of the daily life of users worldwide. The number of Social Media users is constantly increasing year after year, exceeding 4.5 billion active social media users as of October 2021. During the last two years, due to the Covid-19 situation, people understood the crucial role that OSNs play in our life, and the massive impact they have in demolishing the barriers of communication. However, their users started pointing out the problems that are vexing these platforms, such as the one related to the privacy of personal data, or fake news, but also censorship, and the poor value redistribution to content creators, among the others. The dependency on a single service provider and centralized architectures were identified as the possible origin of these problems, thus leading to decentralized architectures for the implementation of social services. Initially, platforms based on Peer-to-Peer (P2P) architectures were proposed, with the specific aim of granting the users a high level of privacy. However, during the last years, the decentralization techniques radically evolved, in particular since the introduction of blockchain technology in 2009. The application of blockchain in OSNs can take many forms, ranging from deploying access control policies as smart contracts, to using the blockchain as a storing mechanism. While there are countless proposals available online, one of the most successful trends is to exploit the blockchain to implement a rewarding system to fight fake news spreading, such as in Steem, Minds, and others. Attracted by the new possibilities that the blockchain can offer to social networking platforms, also centralized platforms such as Twitter and Reddit are considering decentralization and blockchain to improve the quality of the services they provide. However, decentralization comes with a cost, introducing multiple challenges that must be addressed.

The Limitations of Current Online Social Media

Online Social Media platforms, with more than 4.5 billion daily active users, have become the most important Internet services as of October 2021. Their widespread adoption supported human societies all over the World in countless ways, including as tools to keep in touch with friends and family (a crucial role, especially during the Covid-19 pandemic), as sources of information and news in real-time, but also to promote one's activity, seek emotional support, search for help, and discover new interests and people. Thanks to their widespread adoption, people started questioning the fairness of these services, in particular with respect to the privacy of the users' data, and the poor value redistribution. Indeed, there are numerous episodes in which the data of the users was misused by the service providers. The most well-known is the scandal involving Cambridge Analytica, where the personal data of more than 80 million people was analysed for political goals. From the users' perspective, there are also other limitations.

Censorship takes place constantly in Online social media platforms, sometimes carried out by governments and sometimes carried out by the platform owners, mostly to obscure people marching to a different drummer. Fake news is another unsolved problem plaguing Social Media which weakened the consideration of information coming from these sources on one hand and greatly helped the rapid spreading of false or dangerous information on the other hand.

The Need for Decentralisation in Online Social Networks and Media

Scientists, researchers, and developers have identified the centralised structure as one of the possible sources of the problems that were identified in Online social media. Indeed, these services are usually implemented as a collection of geographically distributed servers, but they are owned by the same company, which dictates the terms of service. Therefore, one way to try and find solutions to these problems was to opt for a decentralised approach, where both governance and duty is decentralised among multiple parties. This push gave birth to the so-called Decentralized Online Social Networks: social platforms with similar functionality as their centralised counterparts but implemented on decentralised architectures, such as peer to peer networks. The decentralisation added new value to social platforms but also introduced new challenges to be faced, including data persistence and availability, information diffusion, and privacy preservation. The first platform launched in this direction was *diaspora** in 2010, others followed in the following years, such as Mastodon[1], DiDusoNet[2], Friendica[3], and GnuSocial[4]. The main focus of all these platforms is the privacy of the users, which is enforced according to multiple strategies, such as asking the user for confirmation before sharing certain data with other users or defining privacy policies. In some cases, data replication techniques are also merged in the privacy preservation process, such as data of all users is available to a certain degree, even if the rightful owner is not online. The decentralisation on these platforms is usually managed by a federation of services and, in case one wants maximum control over their own data, she/he can set up her/his own node and become part of the federation. To encourage the transition of the users to their services, some of these platforms decided to implement a certain degree of interoperability. Indeed, while centralised social media platforms have a very limited way to interoperate, many decentralised platforms decided to form a Fediverse[5] which can be understood as a collection of protocols and standards to make all the platforms belonging to it reachable. In the Fediverse a user only needs a single account to reach all other users in each platform of the Fediverse, thus giving much more freedom, and enriching the audience of each platform taken separately.

New frontiers of decentralisation

The decentralised social media platforms such as *Mastodon* and *diaspora** managed to have only limited success in the scenario of social media, failing to gather enough social impact and users to crack the hegemony of their centralised counterparts. However, decentralisation techniques are constantly evolving, further increasing the possibilities for decentralising a social media platform. In particular, ever since its introduction with Bitcoin in 2009, the blockchain is fueling decentralisation in countless services,

[1] https://joinmastodon.org/

[2] Guidi, Barbara, et al. "DiDuSoNet: A P2P architecture for distributed Dunbar-based social networks." *Peer-to-Peer Networking and Applications* 9.6 (2016): 1177-1194.

[3] https://friendi.ca/

[4] https://gnusocial.network/

[5] https://fediverse.party/

including digital assets, auditable supply chains, electronic voting, and so on. Blockchain has also been applied to the scenario of Online Social Media, giving birth to the so-called Blockchain Online Social Media (BOSM)[6]. In short, a BOSM is defined as a social media platform, implemented with the support of a blockchain. The blockchain can support the implementation of social media in many different ways, ranging from the storage of social information to the implementation of a rewarding system or the implementation of privacy policies. Steemit[7] is the first BOSM and was launched in 2016. It is based on the blockchain Steem, which is a blockchain specifically designed to support the development of decentralised applications. It does so by proposing a rich set of transaction types that are tied to social interactions (posts, comments and likes are all transactions), and adopting the Delegated Proof of Stake (DPoS) as a consensus algorithm for fast transaction confirmation. During the last years, plenty of other platforms have been proposed, such as hive.blog, based on the Hive blockchain, Minds, SocialX, based on Ethereum, and many more. The common baseline for all these platforms is the presence of a rewarding system, which is geared towards understanding the social impact of the actions performed by the users and economically rewarding them. The rewarding strategies may vary slightly depending on the platform, but they usually reward at least both content creators, because they put a lot of intellectual effort in producing good pieces of content, and content curators, because they are able to identify pieces of content that have an important social impact.

The introduction of a rewarding system in a social application is mainly motivated by the need to redistribute more equally the profit of the social platform, and, more importantly, to fight fake news. Indeed a rewarding system should encourage people to create only insightful and top-quality pieces of content to create social impact, and content curators should vote for pieces of content based on their quality, rather than based on their personal opinion. The importance of rewarding systems had a strong impact on society, and how they can be exploited to reach a social consensus is still an open problem. One interesting take towards a global social consensus is represented by the platform Yup[8]. Yup is a platform for the evaluation of the Web and, although it can be used to express an opinion (on a 5 points scale) on anything that has a unique URL, such as Non-Fungible Tokens (NFT), images on Imgur or Instagram, or even music on Spotify, it found its natural application to social media platforms, in particular Twitter, Youtube, and Reddit. On one end, this highlights the importance of social media and its impact on modern societies, and on the other end, it shows the need for a rewarding system that is able to create social consensus. The phenomenon of BOSMs and rewarding systems did not go unnoticed among the most important social platforms, which already started their side-projects towards decentralisation. For instance, Meta Platforms, which controls Facebook, started the *Diem Association* to include a blockchain-based payment system to be included in a social platform. Twitter started the *bluesky* project to create a set of protocols and standards towards the decentralisation of social applications, but they also plan to include the blockchain to introduce a rewarding system. Reddit introduced the community points, which are cryptocurrency rewards that can be obtained based on the feedback received on the posts created on the platform. The system is still under development, indeed it is available only in three subreddits, and

[6] Guidi, Barbara. "When blockchain meets online social networks," *Pervasive and Mobile Computing* 62 (2020): 101131.
[7] https://steemit.com/
[8] https://yup.io/

only for one of them the rewards are granted on the Ethereum main net, while for the others the Rinkeby test net is used.

The good and the bad of Blockchain-based Social Media

The introduction of the blockchain in social platforms introduced some important benefits and merits. Firstly, it introduces *decentralisation of power and governance*, meaning that there is no more a single central authority that can impose its own rules. The decentralisation of power also reflects, more broadly, in an *absence of a single point of failure* because the service is provided by a multitude of independent parties. Another crucial aspect is the possibility to certificate *content authenticity* thanks to the innate property of the blockchain of being an append-only structure. A blockchain can also help in fighting *censorship* because it is extremely challenging to be taken down worldwide or be blacked out from a specific country. Lastly, the *rewarding system* can prove to be an extremely powerful tool to fight the spread of fake news, misinformation, and to encourage a mindful usage of the social platform.

On the other hand, the blockchain also introduced some drawbacks. Concerning privacy, if the data is stored on the blockchain itself and the blockchain is public for auditability reasons, all the data stored on the blockchain is visible to anyone, including people not even registered to the service. This opens up to episodes similar to the one of Cambridge Analytica, although, in this case, users are aware that their data will be public, and still everyone has access to it (not only a single company). Additionally, rewarding systems must be designed in such a way that they are fair and cannot be cheated. In detail, they should not introduce biases towards rewardable content, such as making certain topics or content creators more easily rewardable. They should also decouple the direct link between economic rewards and the social activity of the platform, because sociality can be deeply affected by this link, thus creating social activity that is solely performed to gain access to the best possible reward, rather than social activity reflecting the genuine opinion of people. Lastly, since rewarding systems should be geared towards understanding the social impact of the actions of the users, bots and other automated processes should be taken into account when designing rewarding systems, as they can heavily influence the distribution of rewards.

What's Next?

The advent of blockchain had a massive impact on social media, both centralised and decentralised, but no platforms found a clear winning strategy to exploit all its potential and create a groundbreaking service capable of tilting the established balances. Rewarding processes need to be investigated more deeply, as they proved an invaluable tool to fight fake news, but they are also so easily exploitable by automated accounts. Additionally, more factors could be taken into account in the big picture, such as how one can integrate the power of artificial intelligence, sensors, virtual reality, interpersonal trust, privacy, and security with the blockchain to provide the ultimate Decentralised Social Network experience.

Barbara Guidi, guidi@di.unipi.it
Andrea Michienzi, andrea.michienzi@di.unipi.it

FROM ENVIRONMENTAL SENSING TO ENVIRONMENTAL INTELLIGENCE: A SUSTAINABLE APPROACH

PIETRO MANZONI,

DEPT. OF COMPUTER ENGINEERING

UNIVERSITAT POLITECNICA DE VALENCIA, SPAIN

CATIA PRANDI

DEPT. OF COMPUTER SCIENCE AND ENGINEERING

UNIVERSITY OF BOLOGNA, ITALY

JOSÉ MARIA CECILIA,

DEPT. OF COMPUTER ENGINEERING

UNIVERSITAT POLITECNICA DE VALENCIA, SPAIN

Environmental sensing is based on long-term measurements of ecological, meteorological, and hydrological variables. The aim is to provide the necessary information to understand trends, establish benchmarks, and inform policy. To move from "environmental sensing" to "environmental intelligence", several disciplines such as artificial intelligence (AI), social sensing, and Internet of Things (IoT) must work together to improve the services that can be offered. An holistic approach to this problem must offer a framework for the analysis and fusion of heterogeneous information, coming from different sources including (but not limited to) social networks, Internet of Things (IoT) infrastructures, remote sensing, and open data repositories. Moreover, these solutions must be designed in a sustainable way, i.e. reducing the environmental footprint for environmental ICT. A sustainable solution is a solution that has been developed to be long–lasting and environmentally responsible. Preserving resources by minimizing their environmental impact, improving energy efficiency, reducing waste, and adopting new environmentally friendly technology is mandatory in the design of the technology of the following decades. Indeed, citizens must be at the center of this new trend from the outset. Environmental intelligence projects are expected to increase local and citizen awareness of environmental impacts. Making humans an active part of this process will lead to useful and usable product obtained watching people interacting with technology, learning from what they adopt and what they ignore, learning from their behavior. It is important to complement data analytics with research into human behavior and preferences, using their wants and needs to better engineer a solution.

Sustainable use of computation and communication

Fundamental for the sustainability goal there is the need for the efficient use of computation and communication that must operate in face of very limited and variable energy availability. A seamless bond must be created among IoT, Cloud, Edge, and AI by overcoming the many challenges requiring novel approaches and the rethinking of the entire architecture to meet the demands in latency, reliability, and the use of resources. With the increased concentration of data value at the border, Edge Computing has become a vital component of the IoT architecture processing layer; to advance real-time processing of large scale IoT applications requires deploying edge computing where "smart things" (e.g., sensors/actuators, devices, machines, and humans) produce and utilize this information. Moreover, edge computing can also become beneficial to bring advanced IoT solutions in areas where connectivity is scarce and where in general resources are limited, like for example in rural areas and in developing countries. In this sense, special attention must be paid to the so-called TinyML solutions; a fast-growing field of machine learning technologies and applications including hardware, algorithms, and software capable of performing on-device sensor data analytics at extremely low power, typically in the mW range and below, and hence enabling a variety of always-on use-cases and targeting battery operated devices. Sustainability demands high attention of the use of resources implying the design of communication links based on low power long range technologies capable to operate in face of very limited and variable energy availability. It is necessary to develop and optimize network protocols for a variety of LPWAN technologies, including LoRa/LoRaWAN, NB-IoT, etc. to successfully operate on energy-constrained IoT devices. New protocols need to be designed to optimize the connectivity by keeping the link management autonomous and self-adapting while minimizing the energetic costs and band usage. Systems must be autonomous, thus offering some auto-configuration in mesh topology to dynamically adapt to the modification in the topology due to, for example, power outages. Low cost of the used devices through containerization of the application would be desirable, so to make older or simpler hardware usable.

Including citizens in the loop

The explosive growth of social-media networks and of the number of networked objects is leading to more frequent and more complex human-machine interactions that are exemplified by the concepts of human-in-the-loop (HITL) and user-in-the-loop (UIL). Basically, when the machine or computer system is unable to provide an answer to a problem, human intervention is required. In this case, this additional data that goes into the decision-making process is added to the computer's algorithms to perform a specific operation automatically.

An important line of research related to these tools consists in mobile crowdsensing, that is, the analysis and interpretation of the enormous amount of information that is posted daily through mobile devices in these tools. In this sense, social-media networks have become a global phenomenon of communication, where users post content in the form of text, images, video, or a combination of them to express their opinions, report facts that are happening at that time, or show situations of interest.

This new paradigm can be used as a highly available framework to detect possible emergencies due to natural disasters. In contrast to physical sensors (i.e., wireless sensor networks, WSN), these social-media tools could be viewed as social sensors that offer the economic advantage that they do not need to be deployed nor maintained since there is no need to network deployment, and its spatio-temporal coverage is outstanding.

As these interactions intensify, many other categories of human-centric IoT services are emerging. Digital twins, for example, provide a novel class of solutions offering a digital representation of a physical object, process, or service in the physical world, such as a machinery or a larger objects such as buildings or natural landscapes. In addition to physical assets, digital twin technology can be also used to replicate processes to collect data and predict their performance. Another interesting class of services is the so-called physical- or mood-based services based on non-invasive sensors. These devices help measuring some specific parameter of interest remaining hidden or unperceived by the user. For example, mobile sensing method for mapping the mobility of people in large-scale events using participatory Bluetooth sensing methods. This non-intrusive technology for collecting spatio-temporal data about participant mobility and social interaction was used to track COVID-19 spread in various countries.

When we summarize the above examples of services, we find that depending on the environment, requirements and challenges for implementing a particular application can vary greatly.

Our activities

We are working on detailing this approach inside SMARTLAGOON[9], a H2020 funded project under the *Environmental Intelligence* call. SMARTLAGOON, aims of designing an intelligent system to: i) provide a systemic understanding of the socio-environmental processes affecting coastal lagoons systems, and ii) enable assessment of the outcomes of future management options. To this end we will develop cross-cutting and sustainable technology for modeling and predicting socio-environmental processes across different temporal and spatial scales. This will be achieved through a digital twin strategy that allows researchers, stakeholders and policy-makers to collect data in a more cost-effective way, and to create more precise models and predictions to support better decision making.

As a case study, this project uses the Mar Menor lagoon (Murcia, Spain), an ecosystem that supports a great variety of human activities encompassing tourism, agriculture, fishing, and mining that have led to its deterioration. The proposed project is divided into five specific objectives:

- Enable real-time tracking of socio-environmental data, obtained from different sources, including inexpensive sensors, phone apps and crowd sourced data using sustainable information and communication technology.
- Develop new modelling approaches, which combine sensing data, physically based models and artificial intelligence techniques for highly anthropized coastal environments.
- Develop a systems dynamic learning tool, which provides insights into the coupled socio-environmental dynamics for the example of the Mar Menor region to enable and support better management.
- Enable real-time visualization and forecasting of the interplay between environmental and societal systems.
- Disseminate project outcomes through tailored activities and formats targeting key audiences (stakeholders, policy-makers, the general public), including empowering existing networks to exchange knowledge, improving skills related to the use of SMARTLAGOON methodology. Moreover, the project aims to increase local and citizen awareness of environmental impacts through citizen sciences activities.

An important novelty of the SMARTLAGOON approach relies on the holistic view of the coastal lagoon ecosystems. Developing a data-centric technology solution will provide real-time monitoring and forecasting of socio-environmental trade-offs in these ecosystems, aimed at helping policy-makers in their decision- making. It will also enable to increase people's awareness of these trade-offs, which will benefit the understanding and enforcement of applicable legislation.

[9] https://www.smartlagoon.eu

Conclusions

The combination of all sources of information can provide a complete real-time picture of a natural disaster, which can be invaluable for many applications, including validation of flood forecasting models, data assimilation in flood prediction models, pointing satellites to an area of interest, use of instantly detected events for disaster response agencies, support for applications that rely on historical flood information, just to name a few. However, there are several challenges that should be faced when developing applications that make use of data provided by different sources of information. First, it is increasingly common to find different types of information (e.g., text, measures, images, etc.) and, therefore, it is necessary to extract the most relevant features of each element to combine them, and thus increase the information about the context of the particular event. Second, due to the enormous amount of information to be processed, the traditional techniques of semantic information fusion must be adapted and combined with machine learning (ML) techniques and high performance computing (HPC) in order to be able to provide responses in real time from the analysis of these vast amounts of heterogeneous information. Finally, it is important that the outputs of the models will be displayed in a way that different stakeholders and policy makers are able to understand and make decisions from them.

Pietro Manzoni, pmanzoni@disca.upv.es
Catia Prandi, catia.prandi2@unibo.it
Jose M. Cecilia, jmcecilia@disca.upv.es