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PARTICIPATION FROM A GEOSPATIAL PERSPECTIVE

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Partycypacja społeczna w perspektywie geoprzestrzennej

Zarys treści: Uczestnictwo w procesach społecznych i wkład w podejmowanie decyzji są cechami charakterystycznymi otwartego i demokratycznego społeczeństwa. Skuteczne uczestnictwo wymaga wyrobienia świadomych opinii, które w większości kwestii potrzebują orientacji w przestrzeni i oceny kontekstu przestrzennego. Postępująca cyfryzacja informacji (nie tylko) geoprzestrzennych znacznie zwiększyła dostępność przestrzennych perspektyw, jednocześnie ułatwiając generowanie osobistych, zorientowanych na lokalizację poglądów i komunikatów. Dostęp do technologii geoprzestrzennych jest kluczowym czynnikiem łączącym jednostki z bogatą i różnorodną bazą usług danych przestrzennych, które dostarczają niezbędnego kontekstu dla opinii dotyczących zagadnień związanych z określonymi lokalizacjami. Poza tym oczywistym i prostym przypadkiem wyraźnego wspomagania procesów partycypacyjnych przez technologie geoprzestrzenne, artykuł przedstawia szerszy kontekst i kwestie, które należy uwzględnić, projektując udział publiczny. Siły napędowe partycypacji geoprzestrzennej omawiane są z perspektywy technologii, kompetencji i polityki, przy jednoczesnym rozważeniu wyzwań wynikających z dominujących postaw NIMBY (ang. *not in my backyard* – „nie na moim podwórku"), które mogą motywować intelektualne uproszczenia u niektórych obywateli biorących udział w procesach decyzyjnych. Dodatkowo, dominacja mediów społecznościowych w dyskursie publicznym jednocześnie ułatwia świadome uczestnictwo, ale także niesie ryzyko mniej świadomego powielania popularnych poglądów o przeważająco negatywnym wydźwięku. W końcowej części przedstawiono przykłady z doświadczeń dydaktycznych autora, poświęcone wprowadzeniu obywatelskiej nauki na rzecz wspólnego generowania wiedzy, co z kolei stanowi punkt wyjścia do inicjatyw partycypacyjnych. W sytuacji, gdy dowody naukowe są często ignorowane lub konfrontowane z pseudonauką i teoriami spiskowymi, fundamenty dzisiejszych demokracji, opierających się na reprezentacji i uczestnictwie, są wyraźnie zagrożone.

Słowa kluczowe: partycypacja społeczna, nauka obywatelska, demokracja cyfrowa, Cyfrowa Ziemia, NIMBY (ang. *not in my backyard* – „nie na moim podwórku"), obywatelstwo przestrzenne

Abstract: Participation in societal processes and contributing to decisions are trademarks of an open and democratic society. Successful participation requires informed opinions, which in a majority of issues need orientation in and assessment of spatial context. Ongoing digitization of (not only) geospatial information has greatly increased the accessibility of spatial views, and at the same time facilitates the generation of personal location-centric views and communications. Access to geospatial technologies is the key driver for connecting individuals with the rich and diverse collection of spatial data services. These provide an indispensable context for opinions on issues centred on locations. Apart from this obvious and straightforward case for explicit geospatial enablement and support of participative processes, this paper presents a wider context and issues to be considered by designers of public participation. Drivers of geospatial participation are discussed from the technologies, competences, and policies perspectives, also considering the challenges of prevalent 'nimby' mindsets motivating intellectual shortcuts for some citizens participating in decision processes. In addition, the dominance of social media in public discourse simultaneously facilitates informed contributions as well as posing the risk of less informed mirroring of popular views with a predominantly negative attitude. The final section showcases recent sample elements from the author's teaching experience dedicated to introducing citizen science for collaborative generation of knowledge and in turn using this as a backdrop for participation initiatives. With scientific evidence frequently ignored or confronted with pseudoscience and conspiracy theories, the foundations of today's democracies based on representation and participation are clearly endangered.

Keywords: public participation, citizen science, digital democracy, Digital Earth, NIMBY, spatial citizenship

Introduction

Originally, digital geospatial methods and technologies emerged from underlying automation objectives. The drafting of maps, documentation of property boundaries, and even the implementation of pre-defined analytical workflows benefited from early approaches to digital transformation. Results were obtained faster, more consistently and were reproducible. Still, these benefits were realized within the scope of previously established sectors and disciplines.

Over just several decades, the advantages of a geospatial perspective and a pervasive geographical approach were adopted far beyond the traditional spatially focused disciplines of geography, surveying, geosciences, and planning. By establishing GIScience and Geoinformatics as novel fields in conceptual and methodological research, a transversal, trans-disciplinary perspective has taken over. Domains like retail, financial services, logistics, utilities, civil engineering and also ecology, conservation, archaeology and many more today cannot implement their strategies and manage operations without geospatial methods and tools.

The true (potential) strength of conceptualizing geography as a discipline with a focus on generic aspects of spatial organization (Abler et al. 1971), built upon spatial relations, patterns, structures, processes and reasoning, unfortunately was, and still is, rarely fully implemented. Too frequently geographers predominantly focus on – interesting and highly relevant – (sub)disciplines at the environment – society nexus. While this approach enables and requires cooperation with numerous other disciplines, it falls short of establishing a transdisciplinary methodological emphasis driven by 'connecting by location as experts for the spatial view'. Interestingly, these perspectives ultimately were fully adopted through the emergence of Geographic (Spatial) Information Science (Goodchild 1992).

Reaching out across disciplines and sharing the benefits of a spatial view with other domains should not be the main and ultimate objective for a pervasive geospatial approach, though. The established suggestion of aiming education and the development of competences at clearly defined doer – user – viewer roles identify the latter as customers, readers and recipients of information. While this is a valid viewpoint that is certainly helpful in some communication scenarios, our ambitions for the geospatially aware involvement of the general public need to go beyond that.

All citizens, this term being used intentionally instead of 'users' or 'viewers', are entitled to full participation as stakeholders in society. Participation reaches beyond the use of services, but also includes contributions to observations and the forming of public opinion, co-developing pathways to decisions and thus sharing the responsibility for livelihoods and environments. As physical beings, individuals have a naturally localized focus on the current place of residence, of work, or along a route travelled. This focus defines a subjective view on the current surroundings, affecting the perception, well-being and decisions of individuals situated in any given space-time presence.

Due to its origins in map making and remote sensing, geospatial approaches are centred on a 'neutral', top-down and mostly 2D-flattened representation of reality and its perception. With today's technologies of personal digital devices, multidimensional sensing and ubiquitous connectivity, we have the potential to complement the standardized 'objective' map view with the full spectrum of individual views. This, in turn, leads to a more complete picture, in a way comparable to combining a map display with a street view.

Based on the main characteristic of digital geomedia – supporting bi-directional and multilateral communication – citizens are empowered to actively contribute localized observations, but also come forward with questions and suggestions, and therefore to participate in decision making and governance. This has been the focus of earlier public participation GIS ('PPGIS') developments, as e.g. summarized by Sieber (2006) and Elwood (2009), but at that time could not yet leverage the decisive role of personal, mobile and always connected digital devices. The resulting

enhanced potential to fundamentally change the societal dynamics through a much broader involvement in public participation is perhaps the most under-used aspect of geospatial methods and technologies today.

Why should we care? Society today is seriously challenged by a separation between decision makers and affected citizens, by a perceived disconnect of personal and governmental objectives, an increase in inequalities and subsequent segregation and divisions. This leads to loss of legitimacy in governance, conflicts, and ultimately challenges the foundations of open and democratic societies. More fully using the potential of participation and thus giving everyone a voice can and should be the contribution by an explicit geospatial approach to counter this hugely problematic trend.

Looking at the role of individual-centric location enabled action, we actually can distinguish two different but highly complementary lines of action: citizen science as participation in the creation of knowledge, and public/citizen participation as contribution to decision making. Both can and should go hand-in-hand and jointly address the issues identified above. Trust in science needs to replace an increasing scepticism, and oneself being part of the creation of knowledge and the foundations of decisions builds bridges across some present chasms.

Now, why do we discuss the topic of geospatially focused participation in this issue? It is intended as a call for (more) action, to increase everyone's dedication to using location as a bridge between citizens, environment and society. It is desirable to see more initiatives leveraging the huge potential of location-centric online personal technologies and tools to mitigate the many disconnects in societies. Connecting-by-location is one of the most powerful mottos for the geospatial approach. Everyone today is a prosumer of information, acting as producer and consumer, and therefore being more fully engaged in societal processes. In short, we need more participative science in the future!

The backyard syndrome

The famous NIMBY acronym (Brouwer, Trounstine 2024), for 'not-in-my-back-yard', identifies an intuitive shortcut in forming opinions and (mostly) outright rejecting proposals only based on geographical proximity and a focus on perceived individual disadvantages. It might therefore be considered the simplest form of geospatial participation: if it is anywhere near, then I am opposed to it. The concept of 'near' comes with different operationalizations: geometrical distance, visibility, noise or olfactory impact, or any kind of potential detrimental effects on one's environment, property, or livelihood.

A mindset of 'anywhere but here' is characteristic of CAVE Dwellers (CAVE – Citizens Against Virtually Everything). In combination with offering quick and short feedback loops for citizens, a strong negative voting tendency in referendums or petitions prevails within a nearby and potentially affected population, while ambiguous and unconcerned viewpoints lead to a lack of participation elsewhere.

Obvious contradictions are no hurdle for nimby'ism: I want access to public transport, but no tram line in my street; I want to live in a single-family home, but demand easy access to all services even though it is an exclusive, low-density neighbourhood; I want cheap and green energy, but no wind turbine peeking over my horizon; I want to use my car but complain about traffic – this list could go on.

How does all this relate to the concept of geospatial participation? Essentially, we need to fulfil two demands:

– Any yes/no vote on a location specific matter like a development project, a siting or infrastructure corridor issue would need to be tied to the (residential?) location of interest of the respondent. Privacy concerns aside, the nimby factor needs to be measured.
– Whenever possible, binary and 'short feedback' questions should be avoided in favour of embedding participation in a wider systemic and thus spatial context: how we prefer, or suggest to manage mobility demand, energy needs, residential spaces, etc.

Originally, nimby mindsets originated from legitimate health and wellbeing concerns: nuclear waste dumps, high-emission sites and using up wild, diverse nature all are not necessarily driven by me-above-all-others interests. Increasingly, though, the author has the impression that even generally accepted societal needs are ranked far below individual ones, which would ultimately lead to 'egoist anarchism' (Stirner 1995).

Individual-driven communication through social media tends to form public opinion as the aggregate of individual opinions. If the latter are primarily based on subjective personal interests, any common good will suffer from contradictions and conflicts. 'Anyone's freedom ends where another persons' freedom begins' is a fundamental principle of democracy and not easily achieved by voting on simple questions, and certainly not with a nimby mindset.

The justification for an explicit geospatial approach to (most) public participation issues, therefore, is not 'because GIS lets us do it', but to build informed opinions based on a societal and systemic perspective first, and only then to contribute to decisions. One major task for public participation applications, therefore, is to make citizens consider the full context of an issue and solicit responses to 'how to satisfy a legitimate need and where to site a facility for common demand', and to avoid simple yes/no votes on specific proposals.

These thoughts are considered important for the overall design of public participation initiatives, and also for emphasizing the duality of citizen science and public participation. As demonstrated in the *Practical applications* section below, it is highly desirable to first build knowledge and trust in evidence before forming opinions leading to decisions.

Enabling geospatial participation

As such, public participation in societal processes is not a new development in most open, democratic societies. In many cases, explicit spatial issues are concerned, like soliciting feedback for zoning plans, in environmental impact assessment, or for major infrastructure developments. Traditionally, citizen feedback was facilitated and sometimes legally mandated through maps and the encouragement to submit written statements – leading to limited involvement either motivated by the backyard syndrome or more altruistic engagement by civil society actors from NGOs, or informal, e.g. conservation-oriented initiatives.

The evolution of digital technologies did not only speed up and ease steps like map production and sharing documents, but, much more importantly, revolutionized the overall communication framework embedding individual documents and items of information. Communication has changed from mostly uni-directional sharing to a conversational exchange, much of that based on social media (Lin, Kant 2021) or dedicated community platforms.

Within this wider context, the enabling of structured public participation aimed at sharing the pathway towards decisions affecting citizens has evolved into an important strategy for managing convergence of opinions and perhaps even consensus in society. The overall approach is well described in the *Public Participation Guide* (EPA, undated) which does not address the geospatial dimension, but recommends valid generic approaches.

The geospatial component of digital participation is best understood when breaking down the process of understanding an issue into a series of steps. To understand the spatial context of any location, observations or planned interventions are put on a map, allowing for exploration of all themes potentially relevant for the matter at hand. This intuitively will lead to causal interpretations and reasoning about spatial relations. Lastly, we will assess the impact in individual or societal interests and values (Fig. 1).

Pursuing this stepwise process of understanding, from establishing spatial context through mapping, followed by a systemic view explaining relationships and patterns, and only then reaching conclusions and developing informed opinions, is

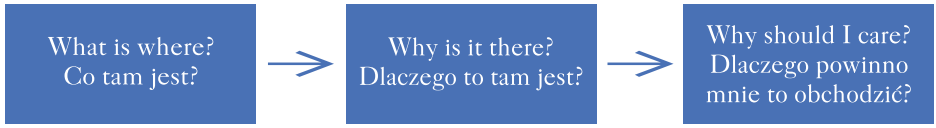

Fig. 1. Adding value and significance during geospatial workflows
Ryc. 1. Dodawanie wartości i znaczenia podczas kolejnych etapów partycypacji geoprzestrzennej przepływów pracy
Source: own elaboration.
Źródło: opracowanie własne.

important to avoid the all-too-frequent knee-jerk arguments primarily based on an ad-hoc reaction frequently echoing someone else's view.

Such a process underlying participation has become accessible to all citizens due to developments in a digital world, where several driving forces are increasingly synchronized. The most visible component certainly is the rapid development of online and 'smart' technologies. These only take effect, though, when users i.e. citizens, acquire the conceptual backdrop and operational skills aligned with rapidly evolving technologies. Both, to some degree, technologies and certainly the 'brainware' (Strobl 2019) for operating these, are driven by policies on several levels. Directing societal digitization towards supporting an inclusive, equitable and just environment is likely the component most difficult to manage within and towards a democratic environment. What is where?

Co tam jest

An early development leading towards, and sometimes directly supporting participation, was the emergence of Volunteered Geographic Information (VGI) (Goodchild 2007), as a conceptual framework as well as a widespread practice. This was instrumental in breaking institutional monopolies (frequently held by National Mapping / Cadastral Agencies and other public bodies) in creating and providing analogue and subsequently digital representations of the real world. VGI also facilitates the collection and sharing of topical data throughout communities of common interest, laying the groundwork for better understanding and action. It needs to be recognized, however, that today most crowdsourced data is collected 'involuntarily' without fully aware consent of the user serving as a sensor and as a sensing platform. Together with several other critical aspects (Elwood 2008), a legitimate caution and sometimes distrust can lead to a conscious opt-out from digital participation, countering the desirable effects of directly participating in a digital and connected society (Fig. 2).

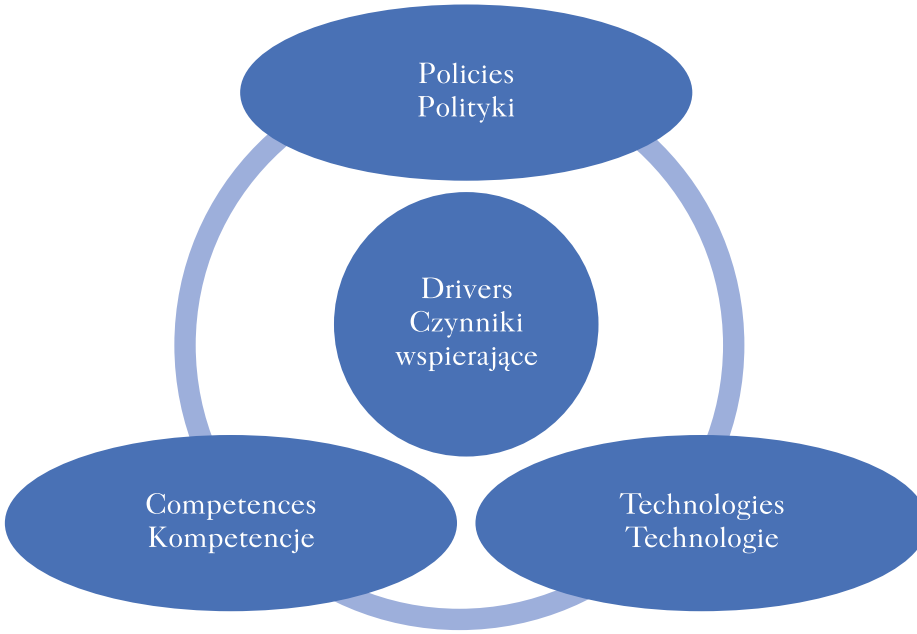

Fig. 2. Enabling dimensions of geospatial participation
Ryc. 2. Wymiary umożliwiające uczestnictwo geoprzestrzenne
Source: own elaboration.
Źródło: opracowanie własne.

Technology drivers

While the fundamental principles and objectives of public participation are independent of technologies and their rapid pace of change, in practice, the huge potential of contemporary approaches to participation would be unthinkable without a set of technologies (Strobl 2014) that have evolved over the past two decades.

This includes, in no particular order, several foundational technologies: ubiquitous mobile (internet) connectivity facilitating live access to any kind of data as well as the real-time sharing of observations and opinions. Layered on top of connectivity is the community enabler of social media services, with groups of shared interest serving as an audience, sounding board and feedback generator for individual inputs.

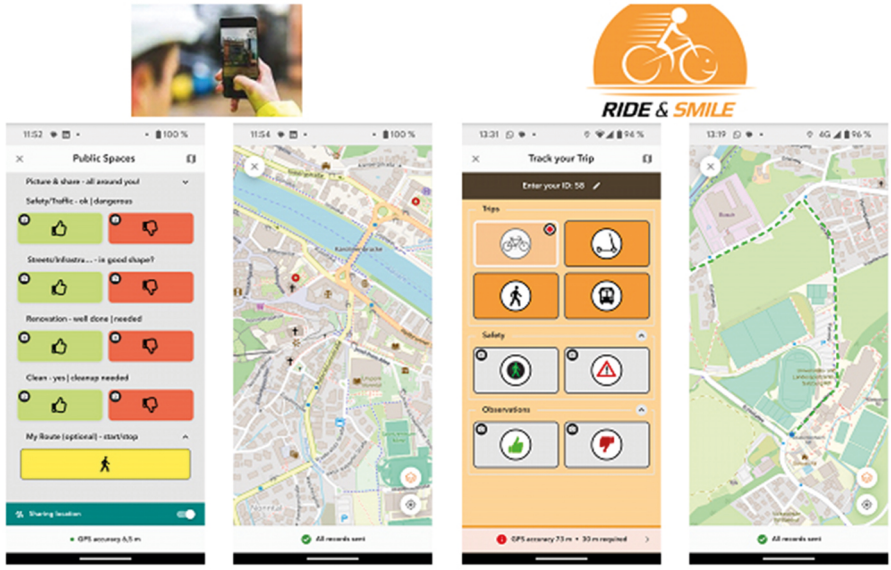

Fig. 3. Simple examples for mobile feedback apps, both directly feeding into shared feature services within the ArcGIS Online platform

Ryc. 3. Proste przykłady aplikacji mobilnych do zbierania opinii, które bezpośrednio zasilają wspólne usługi funkcjonalne w ramach platformy ArcGIS Online

Source: own elaboration.

Źródło: opracowanie własne.

Furthermore, only the pervasive availability of smartphones is ultimately connecting people: a personal digital device combining connectivity and computational power with an array of sensors allowing instantaneous multimedia interaction.

Most people are motivated to participate in forming opinions and contributing to decisions by proximity, by the degree of being potentially personally affected by outcomes – whether it is our proverbial 'backyard' or any other connection to daily lives, routines, or personal interests. The general availability of positioning services, and their full integration with personal technologies like smartphones, watches and also vehicles, connects the real world with digital representations and places all observations and opinions into a place-based context. While we still work with two types of geolocation – remote and scale-independent through maps and imagery, and on-site through positioning technologies – participation gains most of its traction from the in situ presence of actors. Augmented and virtual visual interfaces will ultimately connect both, but still have to make their way into the mainstream.

While the above-mentioned technologies combine into valuable 'field' tools (e.g., Hennig et al. 2023), we need to acknowledge issues arising from too many different tools ('apps') to be managed on smartphones, combined with the challenges arising from data flows and communication requirements between individual apps (Brovelli et al. 2016). The positive impact of integrated architectures and software 'ecosystems' like ArcGIS Online (ArcGIS Online, undated) therefore must not be underestimated. Only such platforms connecting the sensor capabilities of personal smart devices with integrated data management and sharing options via web services lower the threshold for architecting participation applications towards accessibility for low- and no-code developers, and somewhat tech-savvy citizens (Fig. 3).

One huge difference from the earlier days of GIS is the worldwide availability of spatial data, in particular 'background' data like basemaps, imagery and larger scale thematic layers. This is well demonstrated by the Living Atlas (*ArcGIS Living Atlas of the World*, undated), OpenStreetMap, and more recently, Overture Maps, as well as national level resources like Austria's basemap.at (basemap.at, undated), all providing contextual orientation around the proverbial blue dot of a current position or any place of interest. In particular for community-driven participation initiatives, this

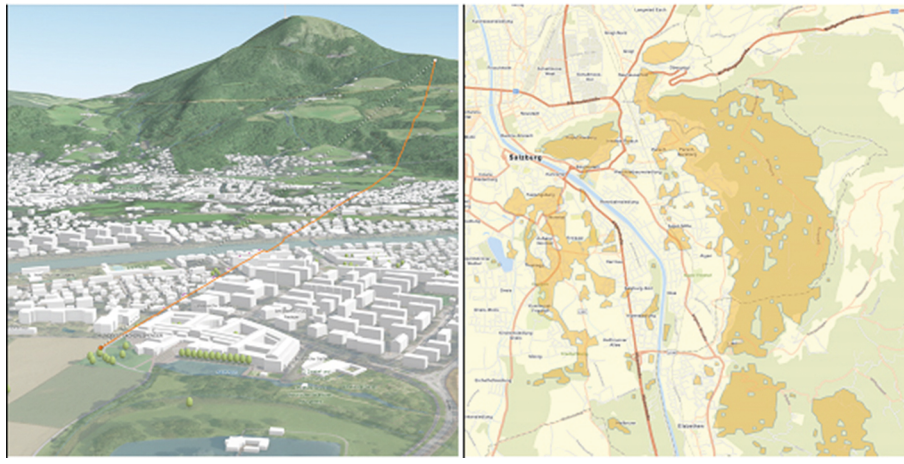

Fig. 4. Alternative renderings of visibility e.g. to assess the impact of a high-rise structure through perspective view (looking east) or a viewshed map (oriented north)

Ryc. 4. Alternatywne pokazywanie widoku terenu, na przykład w celu oceny wpływu wysokiej konstrukcji, może obejmować widok perspektywiczny (patrząc na wschód) lub mapę widokową (ukierunkowaną na północ)

Source: own elaboration.

Źródło: opracowanie własne.

general and low-threshold access to basemaps significantly lowers the entry hurdle.

A significant subset of generic base data is the more recent availability of 3D representations of terrain and the built environment. Together with increasing computational power and, in particular, graphics engine real-time (= while on the move) perspective rendering, these developments bring visual interfaces closer to the everyday experience of individuals, creating a less abstract communication pathway. This also means that the design of participation interfaces has to, but can also choose between directly visualizing a vista or translating the message into more abstract 2D symbology (Fig. 4).

The trend towards digital twins representing construction projects or entire cities (White et al. 2021) also aims at providing a more realistic experience and thus, supposedly, an improvement to participation workflows. Again, the lesser degree of abstraction through individually navigable perspectives and realistic, imagery-based surface textures provides a more immersive environment also translatable into AR/VR interfaces (Simonofski et al. 2024) – altogether generating a smoother and seamless connection between the real world and digital representations.

Finally, ongoing developments of Artificial Intelligence (AI) tools must be mentioned, although a deeper discussion would exceed the scope of this paper. One key aspect of AI applications would be the presentation of topical and contextual geospatial views based on natural language inputs and user profiles, together with the rendering of spontaneously requested what-if scenarios. 'One of the most overlooked benefits of Artificial Intelligence (AI) in the public sector is its potential to make government websites, documents, and communication more accessible to citizens' (Rahim et al. 2024).

Competency drivers

Working with technologies requires competences, based on a combination of conceptual knowledge and operational skills. This fully applies to digital technologies like geomedia no less than the requirement for map reading and image interpretation already needed in an analogue world. With the use of orientation and navigation tools like Google Maps having become a mundane daily activity, basic skills are intuitively acquired from experience by most citizens.

Interpreting maps and spatial data within participative and thus, decision support contexts, should not rely entirely on informally acquired practical skills, as this leaves too much room for misinterpretations of stimuli and subsequently misunderstandings of contexts. The development of competences for working with digital geomedia has been widely discussed in formal education and from curricular perspectives (Gryl 2012; Gryl, Jekel 2012; Vogler, Hennig 2013).

The need for formal education in geomedia competences is frequently motivated from a 'spatial citizenship' perspective (Gryl et al. 2010; 2013), facilitating active participation in society through online technologies accessed through spatial interfaces. As it is widely acknowledged that learning is particularly effective in problem-oriented settings, research-based approaches like the ones implemented through the Austrian Sparkling Science program and similar frameworks successfully address the introduction of geomedia in public participation (Hennig, Vogler 2016) as well as in specific themes like education for sustainability (Vogler, Hennig 2024).

While secondary schools serve as a competency development framework for general education reaching out to all citizens, further and continuing education in geomedia competences (Vogler, Hennig 2013) needs to address multipliers (like educators) and actors in disciplines designing and managing participatory processes, such as planners, environmental managers and public policy implementers. These initiatives currently make progress, although fully establishing the principle of educating for a Digital Earth across the full range of relevant disciplines still has a long way to go (Nazarkulova, Strobl 2023).

Digital competences and skills are frequently considered the longest lasting aspect of digital divides (Vassilakopoulo, Hustad 2023), although in some societies, this is overtaken by conscious opt-outs caused by distrust in the practice and intent of user data collection. This also relates to the implementation of 'communities' by businesses intent on managing consumers' behaviour by stimuli and rewards, often coupled with data collection. Both the actual digital skills gap itself, and individuals' proactive management of volunteered as well as involuntary contributions to the digital universe are matters to be urgently addressed by education and capacity building.

Policy drivers

Technologies, and of course, also capacity building opportunities for competence development, are managed within policy frameworks and in many cases significantly impact the potential and effectiveness of society. This is highly relevant in the context of public participation, even when setting aside the probably most severe policy impacts of restrictions on internet communication, free speech, and general constraints on an open society.

As already indicated above, the move towards open access and more specifically open data (Brovelli et al. 2014) guided by FAIR principles (Wilkinson et al. 2016) certainly is among the greatest enablers of geospatial approaches to public participation. While national legislation does not equally facilitate open (government, national mapping) data in all countries, initiatives like OpenStreetMap are well proven foundations for participation, as they are actually originate from participative

approaches (Haklay, Weber 2008). More recent developments converging on the Overture Maps Foundation are expected to enhance the positive impact of open data on participation.

On an explicit public policy level, the European Citizen Action Service (ECAS) promotes Digital Democracy as deliberative-collaborative eDemocracy: 'reducing the gap between political representatives and citizens, transforming the relationship between EU citizens and EU decision-makers into more of a partnership, thus contributing to the creation of a more engaged citizenship and enabling the EU to go beyond consultations and structured dialogues with the usual stakeholders' (ECAS, undated). This kind of high-level promotion of public participation also significantly strengthens the relevance and ultimate impact of geospatially oriented participation initiatives.

The link between acceptance of scientific evidence as a guiding principle and the building of (more) trust in science and democracy is emphasized in an exemplary initiative put forward by an Austrian ministry, using the metaphor of an interwoven double helix of science and democracy. DNAustria (https://www.bmbwf.gv.at/Themen/dnaustria.html) is primarily designed as a communication initiative and aims to more tightly connecting the general public with science. Citizen Science and participation are approaches perfectly aligned with this kind of policy measure.

Non-governmental actors do not only motivate, consolidate and promote activities by citizens and associations towards broader impact, but can also strongly influence policies. One outstanding example is the International Society for Digital Earth (ISDE) with its working group on Citizen Engagement and Empowerment in Digital Earth. The original idea behind Digital Earth (Guo et al. 2020; Annoni et al. 2023) is evolving into a trans-disciplinary framework focused on the benefits derived from digital representations of Earth's spatial dimensions and characteristics. Facilitating learning, citizen engagement and, thus, participation, are at the core of this mission.

The above-mentioned policy frameworks are only a few examples indicating the importance of policies, in addition to technologies and the 'brainware' of competences as key success factors for supporting open societies through public participation, with a vast majority of themes and issues requiring anchoring in the geospatial domain.

Practical applications

Pursuing the objectives of facilitating and fostering public participation in knowledge construction and participation in decisions requires not only motivated individuals,

but also skills and experience. All this the author has attempted to develop through a mix of educational initiatives within existing curricular and outreach frameworks at the University of Salzburg. This section outlines the scope of such actions, serving as a sampling of possible approaches without prioritizing these over other and alternative initiatives.

In three subsequent academic years (2021–2024), the EU Erasmus+ Blended Intensive Program (BIP) facility was leveraged to implement a course titled Digital Earth Citizens. Jointly organized within a network of partner universities from Central Europe, this full semester elective credit course combined online training in geospatial mobile field technologies with an intensive practical working week in a residential setting. All participants chose an individual participation project mostly anchored in local communities for implementation with a subset of technologies mostly from the ArcGIS Online ecosystem. Through mutual participation in course projects and insights into the diversity of technical, as well as topical experiences, course participants had the opportunity to build a deeper understanding of the power of participation as a key element in citizenship.

From the academic year 2020/21 onwards, a course on Citizen Science and Participation has been developed and offered as an obligatory curriculum component in a (new) Bachelor program on Digitization – Innovation – Society, subsequently adopted into further study programs. This course is implemented as a lecture series showcasing a broad range of practical use cases and case studies from academia, public administration, and industry. Course participants learn to fully appreciate the potentials of more symmetric and participative interaction enabled by digital technologies serving as 'community glue' for engaging across societal issues, functions, and roles.

Originally triggered by COVID-19 constraints, teacher continuing education jointly offered by the Private University of Education Linz, together with the University of Salzburg, is conducted through regular webinar series. These offer an opportunity to expose secondary level teachers to instruments for digital geospatial interaction and thus, the foundations for participation. Today's low thresholds for implementing place- and space-centric mobile applications enable teachers to engage their students with local issues, laying the groundwork for citizenship education through geospatial technologies (Gryl et al. 2010).

As an example, from a more international perspective, the small-scale development research project WaterFlow (Strobl 2024) sponsored by the Austrian APPEAR program, aims to strengthen the scientific foundation and institutional capacities in higher education, research and management in partner countries. To motivate and enable local actors in Central Asia towards an open citizen science approach, the project hopefully enhances the credibility of science in the critical contexts of climate change and water scarcity. A set of community-centric sensing technologies

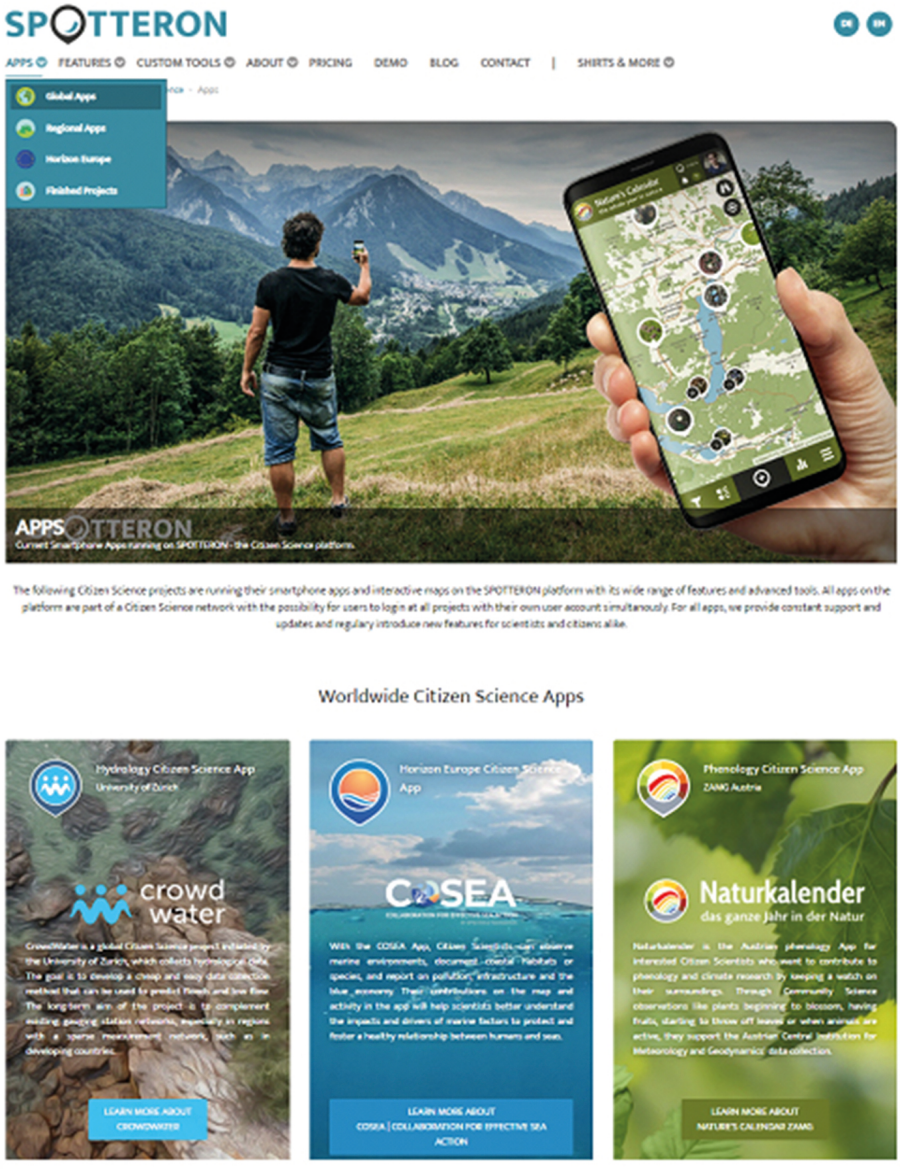

Fig. 5. Range of apps based on the Spotteron Citizen Science framework
Ryc. 5. Gama aplikacji opartych na platformie Spotteron Citizen Science
Source: https://www.spotteron.net/apps.
Źródło: https://www.spotteron.net/apps.

was adopted and put into practice. This included SenseBox (Bröring et al. 2012) installations, the CrowdWater platform (Strobl et al. 2020) for crowd sourced gauging of stream flow, and similar phenology-oriented observation tools (Fig. 5).

The latter is just one example of a broad range of citizen science applications by and for different communities of participatory practice, ranging from conservation to phenological and climate research to participative planning and assessment of social phenomena. Making students and teachers familiar with these application scenarios in project-based learning environments requires easily accessible generic platforms like the environment provided by Spotteron (Hummer, Niedermeyer 2018; Lemmens et al. 2021). Many of these are used across curricula to build familiarity with approaches which are hopefully leveraged later in professional or personal contexts.

This sampling of approaches to bringing geospatially enabled participation into society demonstrates the use of strong multiplication pathways of teachers, schools, and outreach projects. Multiple other initiatives from the author's immediate institutional environment (Hennig, Vogler 2011; Hennig et al. 2023; Vogler 2024) demonstrate the broad spectrum of approaches towards facilitating citizen engagement and thus, supporting critically important drivers of an open and democratic society.

Conclusions and outlook

Public participation in societal decisions, as well as citizen science for collaboratively creating the knowledge informing decisions, have arrived in the mainstream of our digital information society. Since livelihoods, economies and environments have an inherent spatial dimension, participation initiatives need to be established within the applicable spatial contexts. Current practice demonstrates that the technical, qualification and policy requirements exist to make full use of participative approaches to managing our societies and environments.

Obstacles today exist less in the domains of accessibility and various digital divides, but rather in the lack of trust in science, in proper process in public deliberations, and in the authenticity, veracity and origins of online digital content. Scepticism and cynicism are enhanced by malicious actors and tools intent on biasing public opinion and consequently influencing participation. Re-establishing trust based on authenticity and evidence must be the foremost objective to achieve the aims of the democratic process. This still might not be enough to shift all citizens from an ego-centric 'me' towards a communal 'us' worldview, but this is exactly one of the objectives pursued with geospatially enabled interfaces.

Overall, while it might still be too early to promise 'best practice' in geospatial public participation, it is important to pursue good and better practice by gathering experience and feedback through applications across the entire spectrum, where

public opinions are formed, and inputs are solicited. The hurdles towards implementing and publicly sharing location-centric participation interfaces today are minimal, with powerful online platforms easily available for any citizen. Let's just do it, but also manage the fake and ill-intended participants and avoid the sometimes understandable impression of 'tokenism' in the implementation of participation. Improving livelihoods and environments is always worth the extra effort.

Beyond the societal implications and relevance of facilitating participation, research also is challenged to aim at further progress in several fields. The traditional discipline of cartography is making good progress in morphing from a document-(map)-centric approach toward geovisualization in a symmetric communication context. A deeper understanding of spatial perception and thinking is required for improved design of interfaces enabling participation. Information science provides critically important foundations by establishing new data organization paradigms (Sudmanns et al. 2022) and for connecting digital assets online through service interfaces. These still require easier findability and accessibility to lower the hurdle of ICT (information and communication technologies) expertise and ease the leveraging of geospatial resources. Current progress in artificial intelligence not only addresses the latter issue through common language interfaces and generative techniques but also aims at facilitating insights by extracting information from data through predictive approaches.

The objective of enhancing public participation and thus, societal coherence with a positive impact on the balance of power therefore needs support by directing basic research towards innovation in generic spatial sciences. This includes the foundations of geospatial communications, advancing further from spatial data collections towards interlinked online infrastructures (Coetzee et al. 2021), and continuing the enablement of access interfaces as well as semantics-oriented information extraction (van der Meer et al. 2022), also through spatial artificial intelligence. The former paucity of spatial data has given way to the current inundation with data streams, requiring adequate methods and instruments to access, communicate and make sense of from an explicit spatial perspective. These contributions from the field of geoinformatics with a broader Digital Earth outlook (Annoni et al. 2023) will facilitate important progress at the technology – society interface with the aim of stabilizing the latter.

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