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Communication

Rethinking Engagement: Innovations in How Humanitarians Explore Geoinformation

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Abstract: When humanitarian workers embark on learning and dialogue for linking geoinformation to disaster management, the activities they confront are usually more difficult than interesting. How to accelerate the acquisition and deployment of skills and tools for spatial data collection and analysis, given the increasingly unmanageable workload of humanitarians? How to engage practitioners in experiencing the value and limitations of newly available tools? This paper offers an innovative approach to immerse disaster managers in geoinformation: participatory games that enable stakeholders to experience playable system dynamic models linking geoinformation, decisions and consequences in a way that is both serious and fun. A conceptual framework outlines the foundations of experiential learning through gameplay, with clear connections to a well-established risk management framework. Two case studies illustrate this approach: one involving flood management in the Zambezi river in southern Africa through the game UpRiver (in both physical and digital versions), and another pertaining to World Bank training on open data for resilience that combines applied improvisation activities with the need to understand and deploy software tools like Open Street Map and InaSAFE to manage school investments and schoolchildren evacuation in a simulated flood scenario for the city of La Plata, Argentina.

Keywords: disaster management; engagement; games; geoinformation; humanitarian; innovation; open data; Zambia

1. Introduction

Humanitarian workers, development practitioners, community organizers, and other stakeholders are confronting a double-edged challenge. On one hand, risks are rapidly changing as a result of growing disaster risks. The spatial manifestation of hazard, vulnerability, and exposure is evolving due to urbanization, environmental degradation, a changing climate, and other trends. Against this background, the complexity and range of possible humanitarian decisions is rapidly expanding, owing to new technologies to obtain, process, communicate, and use relevant information about what is located where and why it matters. From satellite images to GIS to crowdsourcing approaches for data collection and analysis, disaster managers have at their disposal an unprecedented range of analytical tools to help them understand and address risks. Yet, regrettably, their efforts to embrace and deploy such geoinformation tools seem to be outpaced by the changing threats and opportunities [1].

In order to reduce this gap, it will not be enough to simply train existing staff on new tools with old methods: learning and adequately utilizing geoinformation tools requires disaster managers to not only acquire and retain technically sophisticated details, but also to comprehend the likely obstacles involving institutional, behavioral, communicational, and other dimensions shaping the delays, thresholds, feedbacks, and tradeoffs that shape complex systems [2] and thus determine whether and how knowledge informs action. How can we accelerate learning and dialogue on geoinformation? How can we help disaster managers absorb and navigate the range of methods and approaches that can help them accomplish more with their time, in a context where time for learning is generally not available?

This paper aims to examine those questions by linking two seemingly disconnected topics—geoinformation and gameplay. Usual ways to teach geoinformation tools rarely engage disaster managers in a desire to learn, collaborate, and improvise. Many of today's common yet inadequate unidirectional learning platforms are devoid of meaningful collaboration or situations requiring rapid decisions under stress that mimic the improvisational nature of disaster managers—leaving participants with little recourse other than passive engagement at best. They can be excessively boring and dry, leading to slow and inaccurate progress. Boredom is the brain casting about for new information; it is the feeling you get when there are no new or interesting patterns to absorb. The brain is insatiable in that way [3]. Interactive games, in contrast, can offer numerous advantages over more linear, traditional forms of teaching and learning about geoinformation. Games have the power to communicate complex concepts in an emotional and engaging yet rigorous and effective way; they can transform passive consumers of geoinformation into active players who absorb and retain new data and tools more readily, enabling individuals and teams to experience the value and limitations of what is known and what is knowable. Well-designed games can be seen as engines of epiphany, engines of surprise. During or after gameplay on geoinformation we see disaster managers get the "aha!". The remainder of this paper investigates ways in which participatory, playful activities can help disaster managers be more effective, providing innovative ways to accelerate learning and dialogue to better design and implement humanitarian work.

2. Why Playful Interaction for Geoinformation?

For disaster managers, like for many other professions, learning is necessary—but rarely embedded effectively in the formal or informal incentive structures of their work. For technically demanding fields of knowledge, such as remote sensing and spatial analysis, a humanitarian worker may sense intimidation or even dread when confronting the need to absorb a critical mass of knowledge before it can be put to use. Learners with limited experience can see instructions meandering interminably. As depicted in Figure 1, it is not clear what happens after allegedly useful content is given to a passive audience of geoinformation learners.

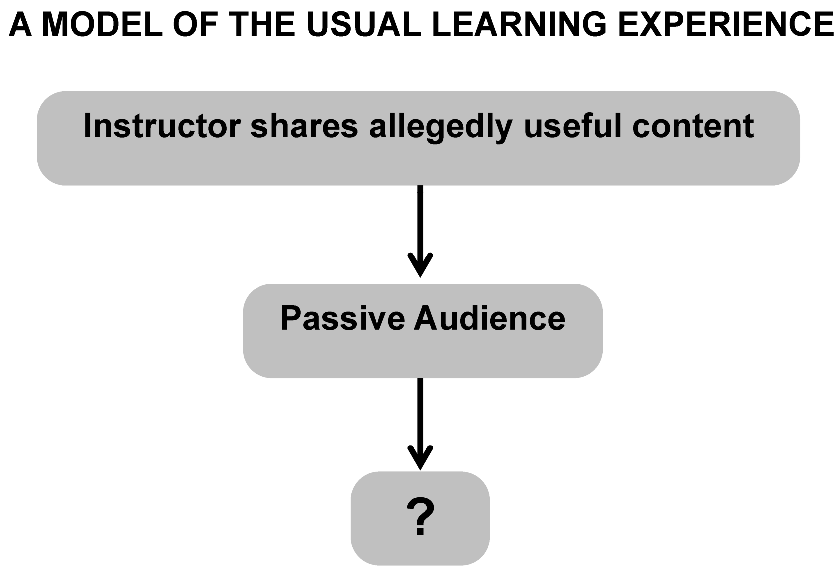

Figure 1. A simplified representation of the conventional learning experience.

Training in geoinformation and related fields over the past decade has been dominated by a frustratingly unsatisfactory learning format: "Death by PowerPoint", the dreaded sequence of slide presentations followed by usually insufficient time for questions and answers. Goodman [4] argues that we are accepting bad, unidirectional presentations as "a fact of life. Low expectations become the norm, and with no real incentive to improve, presentation quality will continue the inevitable slide downward. We can do better". Yet such an approach remains the norm. Any manager in a humanitarian organization that departs from the traditional approach to training and development can expect criticism and questioning from their organization and from other stakeholders [5]. Is it any wonder then that organizations are conservative in their approach to staff training, relying heavily on what is known, even when it is proven to be ineffective? [6]. A different, intensely interactive approach is needed in order to trigger breakthrough learning that can help improve our humanitarian decisions at the pace and scale demanded by burgeoning challenges and emerging opportunities.

Participatory games can help us "inhabit" the complexity of disaster risk management decisions, allowing us through system dynamics modeling to explore, then test geoinformation tools to envision the range of plausible futures. Albert Einstein once said that "games are the most elevated form of investigation" [7]. Abt [8] referred to Serious Games as combining the analytic and questioning concentration of the scientific viewpoint with the intuitive freedom and rewards of imaginative, artistic acts. Well-designed games, like risk management measures, involve decisions with consequences [9]. While games can never fully capture the complexity of disaster risk management decisions, through gameplay these complexities can be revealed, discussed, and processed. Through games we can learn how systems work, and the game-based system rewards us as we learn [10]. Players inhabit, enliven and interpret these systems through play, and are compelled to learn how a game works for the sake of pleasure, discovery, competition and just plain "fun".

Useful games involve emergent systems, which at the core involve what Salen and Zimmerman [11] call a set of "choice molecules": *action* → *outcome*. In other words, an interaction unit that links a possible choice with its corresponding consequence within a designed system. These choice molecules constitute the units with which game designers create larger, organic structures of designed interaction. If created to capture the essential initial conditions plus key cause-effect relationships of a system involving disaster risks, a game-based dynamic model can tell us how each condition will change over time in response to changes in other conditions. Games can take many forms, but are contained within an experiential system described in the iterative model shown in Figure 2.

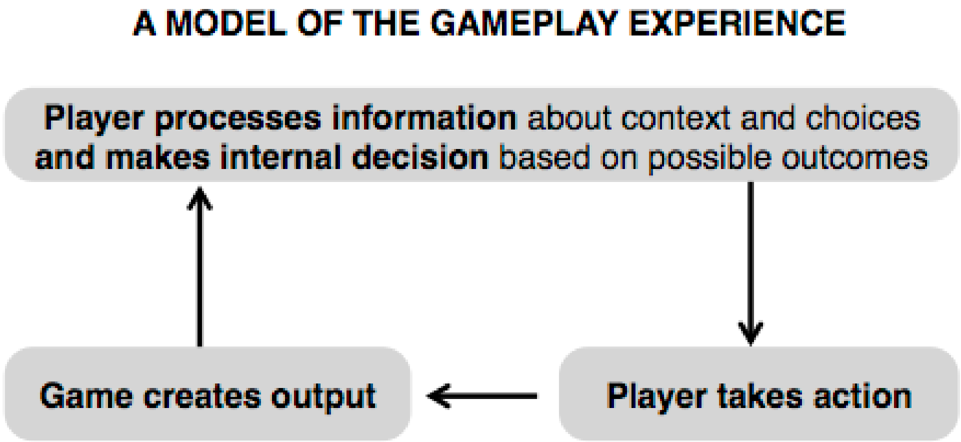

Figure 2. The learning experience through gameplay (from Mendler de Suarez *et al.* [12], based on Salen and Zimmerman [11]).

When a player takes action, the game system creates output by applying rules. This output depends on the player's decision, other players' actions, external forces (e.g., rainfall as determined by a roll of the dice), and context (such as each players' evolving assets and vulnerabilities). Such output later becomes information about new context and choices, either shaping subsequent decisions or determining a win/loss state.

How to frame games as tools that enable credible and effective learning for humanitarian work? Mendler de Suarez *et al.* [12] map the model of the gameplay experience depicted in Figure 3 to the framework for risk management and decision-making formulated by Omenn [13] and illustrated in Figure 3 below.

nymous reviewers for sugat disaster risk management, and therefore the potential role of geoinformation, is an iterative process made of six stages:

(i) Problem/Context: This stage involves:

- Identifying and characterizing existing or potential problem(s) caused by risky situations

- Considering the problem in context
- Determining risk management goals
- Identifying risk managers with the authority or responsibility to take action
- Implementing a process for engaging stakeholders

(ii) Understanding risks: To make an effective risk management decision, stakeholders need to know the potential hazards and vulnerabilities. The risk assessment process consists of gathering and analyzing this information, including geolocated data.

(iii) Identifying and evaluating options: An *option* is a choice among alternatives. Options for potential disaster risk management actions are identified based on available information. Effectiveness, feasibility, costs, benefits, unintended consequences, and social impacts should be evaluated.

(iv) Making decisions: A *decision* is the selection between possible options (including the option of taking no action). Decision-makers review information to select the most appropriate solution.

(v) Taking action: *Action* is motion with purpose—the intentional process of doing something. It results from a decision, and is intended to achieve an aim.

(vi) Evaluation: At this stage, decision-makers and other stakeholders reflect on what disaster risk management actions have been implemented, and how effective they have been. Evaluation consists of the systematic comparison of actual impact against a set of criteria or standards.

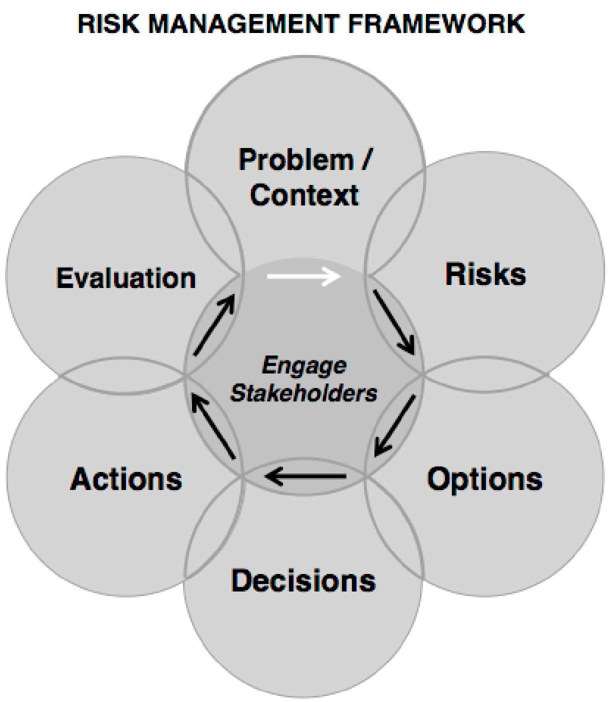

Figure 3. The six-stage "framework for risk management decision-making" (from Mendler de Suarez *et al.* [12], based on Omenn [13]).

Importantly, Omenn's framework explicitly states that the above six steps need not be followed sequentially. The framework depicts a very clear centrality for a homogeneously depicted set of stakeholders, actively engaged in each of the six stages—but not necessarily in the transition between stages. When this framework is put into practice using conventional learning and dialogue processes, there is no easy way to "jump" stages and quickly explore, from the vantage point of any one of the stages, how "distant" stages may be affected, or the challenges that may then emerge. This is particularly true of geoinformation-related data collection and analysis. It must be recognized that in the operational reality of humanitarian work, there is an abundance of sequential, siloed stages dissociated from each other and from the various stakeholders who could and should contribute to thinking and acting on the problem. As practitioners often say: "If it's so easy, why is it so hard?".

Recent experience shows that participatory games are uniquely suited for dynamically capturing these challenges through experiential learning [14]. The Red Cross Red Crescent Climate Centre has designed over 40 games on diverse topics including hurricane preparedness, financial instruments, coastal infrastructure, gender dimensions of food insecurity, and climate negotiations. Successful game sessions were facilitated in events held at cooperatives of illiterate Ethiopian farmers, Scandinavian meteorological services, the Ugandan Parliament, and the White House. Such gameplay sessions have successfully addressed two main concerns in disaster management:

- *Progress can be too slow and iteration rarely happens*. While geoinformation offers tools to monitor and evaluate change over time, the pace of change in hazards and vulnerabilities often outpaces real-world capability of completing the stages in the cycle; feedback from evaluation doesn't inform the other stages rapidly enough.
- *Learning and dialogue outcomes can be too fragmented and ephemeral*. All too often dialogue processes currently used in geoinformation for disaster risk management fail to yield adequate results in part because they create islands of knowledge in a sea of ignorance. Proposed actions based on incremental change and compartmentalization will likely be ineffectual and not sustainable due to incoherence relative to the dynamics of the whole system.

There are two important advantages in using participatory games as ways to explore and expand the role of geoinformation for disaster management:

- Time and space compression: Games allow to simulate, in an hour-long activity, a multi-year or even multi-decade future, experiencing how today's actions may shape next year's context and choices, which in turn affect the context and choices of the longer-range future. Similarly, playful activities can create a fictional representation of space that compress a small village, a large river basin or even the entire planet in a game board or other spatial representation of geography.
- Agency: Games capture relationships between system elements in a way that gives agency to the person or persons engaging with the spatially explicit model: players' decisions can shape the system, affecting the range of plausible future decisions. Games are particularly conducive for collective learning and participatory action research [15].

Sterman [16] suggests that poor performance in dynamically complex environments arise from people's misperception of feedback and, in particular, from individuals' insensitivity to the feedback that their actions create in the environment. Given decision-makers' need to manage the increasing complexity of geospatial information and tools, serious games can play a critical role in training for humanitarian and development systems.

In addition to the playable system dynamic models described above, a very different set of playful activities can also help disaster managers rethink the role of geoinformation as they confront the need to feel comfortable and connected in the face of the unknown: applied improvisation. Borrowing methods, skills, and mindsets from improvisational theater and jazz, applied improvisation aims to help participants from disaster management and other "real world" fields to become better *prepared* for things they cannot *plan* for [5]. Optimal improvisation requires overcoming initial and natural stress reactions, whether when confronting search and rescue tasks after a catastrophic hurricane, or when confronting a mandatory course on GIS for mapping flood risk. While new situations evoke instinctive, yet often counterproductive freeze, fight, and flight reactions, the improv mindset instead proves a valuable tool to effectively recognize and build on new opportunities being offered. The applied improvisation approach can help disaster managers feel confident, creative, and resourceful, despite circumstances [17]. Applied improvisation is fully aligned with the experiential learning approach to learning and development: "a process whereby knowledge is created through transformation of experience" [18].

The following section of this paper illustrates how the participatory frameworks described in here offer opportunities for innovation. Two recent experiences involving playful approaches to learning and dialogue on disaster management are examined as ways promote the use of geoinformation: the game *UpRiver* in Zambia, and a set of game-based activities for training on Open Data for Resilience commissioned by the World Bank.

3. Case Studies

3.1. UpRiver: A New Approach to Community-Based Flood Warning Systems

The literature points to the relevance of predictable problems involving how forecasts are formulated, communicated, understood, trusted, and used—or not [19]. With a few notable exceptions such as the Famine Early Warning System Network (FEWS NET), humanitarian organizations remain largely dissociated from the scientific institutions and forecasting tools that can help understand the options for managing climate-related threats. In the context of a research project on humanitarian policy and practice in a changing climate, the Red Cross Red Crescent Climate Centre partnered and the Zambia Red Cross Society joined forces to address this issue, specifically for flood risk management along the Zambezi River Basin.

Two main challenges had to be addressed. On one hand, subsistence farmers living in communities on the Zambezi floodplain lack a full understanding of the mechanisms that cause flooding (*i.e.*, extreme rainfall upstream predictably traveling down the river): many of them do not benefit from the predictability of riverine inundations, and experience the rising waters as if they simply materialized in their village as the result of divine punishment or bad luck. Such lack of awareness, combined with diverse intra-community patterns of vulnerability to flooding [20], creates important challenges for humanitarian initiatives aimed at linking early warning with early action to avoid flood losses. On the other hand, insufficient geoinformation about river levels over time make it very difficult to develop and calibrate predictive models of flooding in the Zambezi and other river basins where extremely vulnerable communities depend on humanitarian organizations for disaster preparedness and response.

In order to accelerate and improve risk management decisions, the Climate Centre and partners have developed the concept of "forecast-based financing for disaster preparedness" (FbF): an approach for catalyzing humanitarian action based on extreme weather and climate forecasts [21]. In essence, disaster risk management efforts traditionally focus on either long-term preventative measures or post-disaster response. Outside of these, there are many short-term actions, such as evacuation, that can be implemented to reduce the risk of impacts during the precious window of opportunity before a flood happens but after science says that extreme rainfall or river levels associated with flood losses have been observed upstream, or are likely to happen. However, this opportunity to anticipate extreme events is regularly overlooked, leading to avoidable losses or unnecessarily expensive measures that are triggered too late. FbF is a novel forecast-based financing system to automatically trigger action based on forecasts or observations. The system matches threshold forecast attributes with appropriate actions, disburses required funding when threshold forecasts are issued, and develops standard operating procedures that contain the mandate to act when these threshold forecasts are issued. Such a system can be scaled up in flood-prone areas worldwide if adequate forecasting tools are made available—which is, for now, rarely the case in river basins with extremely vulnerable populations.

This case study shares an innovative approach to support forecast-based financing for disaster preparedness through the game *UpRiver*, an activity that uses game mechanics to bring play and serious real-world processes together, so that real action occurs while playing—what Gordon *et al.* [22] describe as "engagement games"—resulting in better action, more trust, and civic learning. UpRiver has two versions, a physical game, and a digital game.

3.1.1. Analog *UpRiver*: Improving Understanding of Flood Predictability at Community Level

The core idea of the physical, analog version of UpRiver is to mimic the dynamics shaping floods and the success or failure of disaster preparedness in a river basin. The game was played with subsistence farmers who live and farm along the Zambezi River floodplain in western Zambia—the very same stakeholders who would benefit from understanding and acting upon flood warnings. Players receive a limited budget in the form of beans, and form a line that represents communities along the river floodplain separated tens or hundreds of kilometers (see Figure 4). Each player holds a cup with markers indicating river level in her community, and experiences changes in river level through time (captured in a sequence of rounds) through two mechanisms:

- *Rainfall*: water is added to each cup based on a roll of the dice representing precipitation: if a 6 is rolled, a large sponge is dipped in a jug and then used to "rain" a lot of water on the cup; if a 1 is rolled only a small sponge is used, and a medium sponge is used for intermediate values of rainfall.
- *River flow*: players pass water from their cup to their neighbors' cups downstream, representing river discharge following the force of gravity.

If the combination of river flow and rainfall causes a player's cup to overflow, such an event represents a flood disaster: all her beans are lost—unless the player invests in flood preparedness (which costs a few beans, which of course would be wasted if preparedness measures are taken and then no flood materializes). Players can use their beans to purchase data about river level upstream and estimate the chances of flooding on any given turn—thus informing whether preparedness measures are worth deploying.

Figure 4. Zambian subsistence farmers play the UpRiver game in the village of Kazungula to learn about the predictability of changing water levels on the Zambezi river. The game helps players understand the value of self-organization for flood warnings and disaster preparedness.

Game sessions in Kazungula and Sesheke in western Zambia proved extremely successful: participants were intensely engaged both in the game and in the flood risk management planning session that followed. The system dynamics involving floods, early warnings, and people's behaviors were sufficiently captured in gameplay and discussed during debriefing and planning. The combination of collaboration and competition offered by UpRiver created an atmosphere of laughter, anticipation, and bonding that substantially increased their appetite for asking questions about flood predictability and disaster preparedness measures. Players reported understanding the need and value of flood warnings like never before, and were eager to turn the simulated experience into real-world action [22]. Importantly, the game helped create bonding between farmers at risk and Zambian Red Cross staff and volunteers. The benefits of gameplay transcend the learning objective and result in better relationships between those with problems and those who can help organize solutions.

3.1.2. Digital *UpRiver*: Community Led Data Collection to Improve Flood Predictions, and Trust

The digital version of UpRiver builds on the narrative of the physical version, but with an important innovative twist: the prototype digital game is scaffolded onto the real world, allowing for what Haklay [23] calls "participatory sensing". Instead of cups depicting fictional river levels, players observe real water levels through existing limnimeters along the river, and report those river levels via text message to a specially designed web-enabled platform. Additionally, players submit their "forecast river level" (a guess) with a certain lead time—for example 48 h. Among the various players in any given community, whoever submits the water level value that is closest to the observed value wins ten points. Through the digital game system, participants can use their points to acquire information about river levels upstream in order to try to improve their guesses. In this way, players are invited to develop an understanding of the dynamic nature of water levels in the river basin.

The game is played throughout the time period where floods are likely. At the end of the rainy season, the player who earned most points within each community turns those points into a prize, *i.e.*, something of real value (such as cash, a Red Cross t-shirt, or mobile phone credit). This gives people incentives to read limnimeters and engage in collecting and submitting geoinformation that will help researchers to calibrate hydrological models and thus produce better flood forecasts.

Eventually when a good-enough hydrological model is calibrated with the support of the crowdsourced river data, the game facilitation team will add the predictive model as a player (possibly called "Mike", the name of a well-known tool for flood forecasting). Participants who submit their forecast before the deadline will receive a text message one minute after the deadline, indicating what Mike's prediction was. Players that perform better than the model also earn a point. This incentive will help participants notice that the model tends to be make good guesses when river levels are unusually high: after several rounds noticing the forecast skill, if Mike predicts the river level to be about 3 m above their home's kitchen floor, they are more likely to start running to higher ground with their valuables. Eventually the trust earned through gameplay should help the Red Cross help communities take the early warning seriously.

Another innovative effort for Climate Change Adaptation (CCA) seeks to disburse funding for humanitarian action prior to a disaster, allowing communities to prepare for the oncoming forces of events such as floods or droughts, rather than simply react once the damage has been done. As Dr. Maarten van Aalst, Director of the Climate Centre, states, this innovative way of looking at disaster relief is "***'Early Warning, Early Action' in the truest sense.***"

DEVELOP has found a dynamic and forward-thinking partner in the Red Cross/Red Crescent Climate Centre, and the invaluable engagement of Erin Coughlan. Keep on the lookout for more fascinating collaborations in the future!

More information on the Red Cross/Red Crescent Climate Centre may be found at **http://www.climatecentre.org/**, *and results from this Spring term partnership can be found at* **Earthzine.org**, ***"Validations of Precipitation Inundation Aberrations for African Nations."***

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Figure 5. The game UpRiver, facilitated by a Red Cross volunteer from the village of Kazungula in western Zambia, was featured in a NASA publication to highlight the value of flood prediction. Engagement games can help raise awareness and visibility of initiatives involving geoinformation.

A NASA [24] publication recently featured a rocket launch in the cover. As shown in Figure 5, page 47 shows a photo of a Red Cross volunteer called Moono Mutambwa playing the UpRiver game with subsistence farmers in the floodplains of the Zambezi river. One can wonder: what are the chances of a Zambian Red Cross facilitator from the village of Kazungula appearing in a NASA publication? This serious yet fun game continues to help local, national, and global humanitarian efforts to rethink the role of science to prevent disasters: we aim to work with others to make climate related forecasts focus on extreme "threshold" events, to characterize of the full range of variability over time; to pay attention to implications of model uncertainties; and to produce a clear, jargon-free and succinct outline of insights to support decision making [25].

The idea of crowdsourcing geoinformation for flood risk management embedded in UpRiver is now being integrated into a project implemented by the Togo Red Cross in the Mono River Basin downstream of the Nangbeto Dam, in West Africa. Funded by the German Federal Ministry for Economic Cooperation and Development through the German Red Cross, and with technical assistance from the Climate Centre, this project engages the Togolese Open Street Map community to develop software tools for acquiring, processing and sharing geoinformation in real time—such as geolocated data on river levels, which will help predict floods and trigger disbursement of funds for targeted early action, including community-level early warnings as well as prepositioning of items to manage or reduce flood impacts.

As reported in a research roadmap for human computation [26], this endeavor can at a later stage support "citizen cyberscience": online participation in scientific research by members of the public [27], for example by creating a shared approach to flood prediction modeling, offering some people and teams with expertise the challenge to design the conceptual architecture for physical or statistical representations of the interactions between hazard and vulnerability, while laypeople take on simpler but valuable tasks like volunteer computing.

3.2. Open Data for Resilience: Interactive Learning about Digital Tools and Institutional Frameworks

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership managed by the World Bank. Working with over 400 local, national, regional, and international partners, GFDRR provides grants and technical assistance, and serves as a global platform for knowledge-sharing and capacity building for disaster and climate resilience. In March 2014 it launched the Open Data for Resilience Initiative (OpenDRI) Field Guide [28], a practical manual aimed at setting foundational standards for the open source creation and communication of geoinformation. Its contents include basics of why disaster management can be improved though open data, as well as specific software tools such as Open Street Map for data acquisition, GeoNode for developing geospatial information systems, and InaSAFE for impact assessment.

While conventional training sessions could have helped disseminate the diverse, rich contents of the OpenDRI Field Guide, the GFDRR team decided to innovate and embed the training into a playful, experiential learning setup: participants were to be immersed in a simulated situation that required them to take on roles representing real life stakeholders. Responding to a set of defined rules and acting on the information given to them as they would in the real world, trainees would need to try the ideas and tools presented as part of a half-day training to guide decision-making and their responses to the disaster risk management scenarios and options presented to them, slowly built elements and relationships that capture the complex system dynamics of how and why open data is used or misused, in a way that was both serious and fun. The remainder of this section describes in chronological order of gameplay the sequence of components of the game-enabled learning experience, originally designed for an afternoon training session held with about 30 participants from around the world at the "Understanding Risk" conference.

3.2.1. Introduction and Forming Sub-Groups

After an overview of the objectives and participatory approach of the training session, players received unique "Identity Card" badges, thus assigning them three kinds of attributes: *Region* ("North", "West" or "South")*,* *Sector* ("Edu" for Ministry of Education, "Gov" for Ministry of Government Planning, or "Org" for Civil Society Organization)*,* and *Color* ("Blue", "Yellow" or "Green"), to be used later for the formation of teams collaborating and competing to manage flood risk. These fictional identities were associated with roles and responsibilities in the city of La Plata, Argentina, chosen for this activity because of its easy-to-navigate street pattern (rectangular grid with numbered streets) and good availability of flood-related data. In order to help participants get a sense of who they are both in the real world and in the fiction of the game, the usual approach could have been used—*i.e.*, each person stating name and affiliation (which is very time consuming and sets a boring atmosphere). Instead, the activity "answer with your feet" was used, whereby the facilitator asks people to walk to different parts of the room depending first on their real attributes (gender, familiarity with GIS, *etc.*) and then with their fictional attributes assigned through the ID cards (region, color, sector). This physical activity allows participants to visualize the diversity in the room and sets the tone for the rest of the session.

3.2.2. *Snap!*: A Warmup Activity to Elicit Participants' Ideas on Open Data

"Snap!" is based on a British card game, adapted for serious learning with three aims:

- Energize participants: activate people's brainpower (crucial for sessions after lunch)
- Create a sense of shared identity among participants of the same sector (Edu, Gov, Org)
- Learn from participants about what concepts they associate with Open Data

In the "Snap!" game session, players first paired up with someone else from the same sector, then went through cycles where they have to quickly come up with a set of concepts (forming in their minds a deck of imaginary word cards), then state those words in sequence at the same time as their partner (as if they were simultaneously flipping the imaginary word cards and stating the word contained in each), trying to react faster than the partner if a certain type of circumstance emerges: when both players say the same word at the same time, the first player to say "Snap!" gets all the imaginary cards and earns an imaginary point. The first cycle is easy and intensely fun, and promotes bonding through shared laughter and surprise. Then complexity grows until in the third cycle players must come up with word cards related to the topic of the session (*i.e.*, "Open Data for Resilience"). They tend to confront a "clogging" of ideas that builds their appetite for crystallizing and discussing concepts ranging from "map" to "software interoperability".

An additional, short group activity elicits those concepts in actual word cards (blank papers), allowing the facilitation team to create word clouds that illustrate and show their current state of understanding of the issue. The same activity can be deployed in less than 5 min at the end of the session, for a quick and fun way to assess whether the participants' understanding of the Open Data issue has evolved in any way as a result of the afternoon activities (see Figure 6).

Figure 6. Examples of wordcoulds emerging from the game "Snap!", illustrating concepts that players associated with Open Data for Resilience after and before the participatory training session.

3.2.3. The Challenge: Flood Risks in the City of La Plata: Basics of Geography and Tasks

In this brief session, following the shared awareness of what people think of Open Data for Resilience', participants are introduced to the case study of the city of La Plata, including its street layout and its changing flood risks. Players learn that the simulation game is a simplified representation of reality, including many unfortunate aspects of the real world that do matter, such as incomplete data, confusing instructions from bosses, and "glitches" in technology. Like in the real world, some changes in land use and some information in recently developed urban areas are not well captured in maps. The map printouts distributed to players are decidedly incomplete, depicting most but not all schools in La Plata.

Teams share budgets and decisions. Diversity within a team shapes gameplay incentives. Trios of players defined by sector can win "performance points". The first task for players involves mapping the schools in La Plata, in order to support investment planning for decisions involving both computer equipment (a task for "Edu" players) and flood retrofitting (a task for "Gov" players). At the end of the day, the trios with most performance points will win prizes (one for ".Edu", one for ".Gov", one for ".Org"). The simulation compresses time, encompassing from 2005 to 2020. Players are told to expect tight deadlines, substantial time pressure, and surprises.

3.2.4. OSM: OpenStreetMap Data Acquisition by Sector

This is the first task involving the technical skills acquired during the morning session: Focus is on performing basic data entry and tracing of imagery. Participants begin in "Sector Trios" (each trio comprising the North + West + South regions of the same color and sector). Each Trio has access to a computer, receives some beans (which represent currency to be used later in the sequence of tasks) and is given a Memo: a document from their fictional superiors indicating their objectives, basics of imminent and future tasks, and a sense of their incentives and constraints. Each "Edu" and "Gov" Trio has 20 min to create a digital map of certain La Plata schools using Open Street Map (OSM). They receive a unique list with the IDs and precise addresses of a subset of schools (reliably provided by ministry colleagues), plus IDs and vaguely defined addresses of additional schools with insufficient information to geolocate them, unless "Org" players engage ("Org" players are the only ones who have access to the fictional space where schools can be visited and geolocated).

Players are welcome to interact, share information, trade beans (to fund Org players so they do collect data from the field), whatever helps them accomplish their task within the tight deadline. Gameplay, like data acquisition in the real world, usually reveals underlying tensions and problems regarding how individuals behave with other stakeholders within and beyond their team—an issue that explains a lot about obstacles to open data. For that reason, the next activity focuses on negotiated interactions.

3.2.5. "Negotiating Data": An Energizer on the Challenges of Open Data

"Negotiating Data" is a fast-paced game that allows for the emergence of selfish and myopic behavior (one of the causes of insufficient progress in Open Data initiatives). Participants form separate clusters by sector ("Edu", "Gov" and "Org"). Each cluster will hold different, indispensable assets that need to be combined to achieve results: "Gov" clusters receive a limited supply of *post-it* notes, "Edu" clusters receive two unsharpened wooden pencils, and "Org" clusters receive one pencil sharpener. The facilitator explains that each cluster has strictly 3 min to get as many "Data Catalogues" as possible loaded in their internal IT systems (represented by a large, labeled paper on the wall). In the fiction of the game, a "Complete Data Catalogue" is a post-it note stuck on the IT system, with the three-letter name of the cluster on it, written with a wooden pencil. When the countdown is complete, each cluster earns more or less beans depending on their performance.

By creating scarcity, interdependencies, and a deep sense of ownership of assets that each team thinks is the most valuable, this activity begins with a situation that is analogous to the current world of disaster-related data. In the words of the OpenDRI Field Guide [28]: *"Before an OpenDRI engagement, decision makers and their datasets tend to be loosely connected (...) existing stocks of data which remain latent, inaccessible even to other ministries and municipalities because they are in forms that prevent them from flowing freely. Some are frozen on paper. Others are blocked by* *technologies that lock datasets into proprietary ecosystems, stoppered by policies that prevent release beyond small groups, or fragmented into bureaucratic silos that require significant investment to assemble back into a whole picture (...) Catalyzing and sustaining change is difficult. Without continuous funding, most development efforts falter, brain drain may pull key talent to other organizations, and stakeholders revert to the data sharing practices that they used prior to the OpenDRI engagement."*

The narrative and mechanics of this activity mimic some of the *perceived* incentives and disincentives working against *Open Data* approaches for disaster management, triggering the emergence of emotions, and behaviors that lead to lack of collaboration. Importantly, even though the game rules create an aura of competition, the actual task for each cluster is simply and clearly stated as getting "as many as possible" (not in comparison to other teams, but in absolute terms). This playful activity provides rich, deep experiential learning about the individual and collective forces that can lead to absence of at least one of the five principles of Open Data (*Technical openness, Legal Openness, Accessibility, Interoperability,* and *Reusability*). A very short debriefing elicits key emotions and insights about how existing data sharing mechanisms foster or impair open data policies.

3.2.6. Resource Allocation Task

This task has two components: first a flood impact scenario, and then investments in schools. In the fiction of the game, there has been so far no data about past flood damage to schools. At this stage the facilitator indicates that all players will have access to a digital map with the output of a hydrological model of the 2002 flood event. There might have been changes since then due to urbanization, drainage infrastructure, *etc.* so that rainfall identical to the 2002 extreme event would cause different flood impacts in the near future. The tasks include setting up *QGIS basic* (create new project, load layers), downloading data from *GeoNode* (Flood 2002, school data), and running *InaSAFE* impact analysis to see which schools flooded in 2002. Players have to complete this impact analysis in 30 min.

If well executed, the resulting map provides actionable information for the three "Color" teams (of nine players per color, combining different sectors and regions). Each "Color" team has to allocate their beans to school improvements, with four choices for each school:

- Do nothing (no cost)
- Computer equipment purchased and installed (cost: 1 bean per school)
- Flood proofing, ensuring that no schoolchildren are at risk should a flood occur, and that future flood damages are minimized and easy to recover from (cost: 2 beans per school)
- Flood proofing *and* computer equipment for the same school: (cost: 4 beans)

By the firm deadline (less than 15 min from the end of the impact assessment), each color team needs to invest their beans in computer equipment and/or flood proofing for each school—using a special form (each school has a numeric value ranging from 1 to 8 which defines how many performance points can be earned for each school, creating a spatial heterogeneity that needs to be considered when players negotiate how to allocate resources). Flood risk needs to be considered: It would be wasteful to retrofit a school that will not get flooded, and giving computers to schools that will get flooded would lead to avoidable losses.

Importantly, the "Edu", "Gov" and "Org" sectors have different incentives for shaping investment plans: "Edu performance points" are earned if a school is equipped with computers by the end of the year 2020 (note: if a school is damaged by floods, the computers are lost); whereas "Gov performance points" are earned if future flood damages to schools are avoided; and "Org" performance points are earned by minimizing the number of schoolchildren negatively affected by future floods. At the deadline, the Facilitator invites participants to find similarities and differences in the investment choices made by the various color teams.

3.2.7. Warning! Evacuate Schools? (InaSAFE Impact Assessment)

This task involves basic management of spatial data on schools and flood risk, given fictional forecast information about high probability of an imminent, unprecedented storm leading to very severe flooding in 6 to 12 h ("likely much worse than the 2002 floods"). To mimic real-world disaster management conditions, participants are given an extremely short time to download population data from *GeoNode*, and then use *InaSAFE* to run a flood impact analysis on schools and population to support some difficult decisions.

Players must announce which if any schools they will evacuate (a decision in the hands of "Gov" players), which schools they will turn into flood shelters (a decision in the hands of "Gov" players), and what quantities of food and water will be secured and stocked to manage flood-related needs (a decision in the hands of "Org" players). There are consequences to player's decisions, including negative points for wasting resources if acting in vain, as well as for avoidable losses if failing to act.

When the deadline is reached for evacuation, shelter and relief items, participants are invited to reflect on the similarities and differences emerging from the investment patterns and the underlying decision making processes. Then a map is shown with the actual flood-affected areas during the severe flood of April 2013 in La Plata—an event that led to the loss of almost 100 lives and substantial damages to schools. This of course was caused by extremely intense rainfall… but most people would not have died if they had moved less than 2 m upwards, or less than 200 m away—or if schools had been properly retrofitted. The natural hazard would likely not have become a disaster if, before the rains, there had been a collective effort by various stakeholders to better understand flood risks, identify critically vulnerable areas, set up plans for early action based on early warning, and—importantly, taken advantage of the opportunities offered by Open Data to facilitate learning and dialogue. This activity consolidates many aspects of the training objectives, not only the technical content of software tools but also the principles of open data and interinstitutional collaboration.

3.2.8. Debriefing: What Have We Learned?

The final session distills insights from the half-day interactive experience, combining key lessons and ideas for implementing new tools and mindsets in the concrete work of participants as they return to their real-world tasks. This game-enabled approach to training disaster managers and other stakeholders on Open Data for Resilience has been deployed in very diverse settings, ranging from World Bank staff in Washington, DC to government and civil society officials responsible for flood risk management in Malawi, southern Africa. The facilitation team at GFDRR reports that the playful nature of the designed event has been very successful in motivating participants to stay engaged throughout the entire training session—as opposed to the rather dry and detached attitudes that often resulted from conventional workshops based on unidirectional training followed by clear but not playful tasks to deploy new skills. Importantly, both trainers and organizations asking for the training are more motivated to further reach out and disseminate the valuable OpenDRI toolkit and mindset.

4. Conclusions

As humanitarian workers confronting too much to do with less than enough time, resources and knowledge, we have been making the best wrong decisions we can make. Throughout history we have responded to events; now we are in a position to respond to information about likely future impacts by taking smart, timely action. This change offers enormous possibilities but also substantial difficulties, requiring a balance of analysis and intuition. Now we must see what is newly possible.

The remarkable growth in our ability to collect, process and disseminate spatial data deserves the label of "disruptive": linkages among a set of available options have reached a point where it is feasible for disaster managers to change our thinking and practices, accomplishing more with less. Yet geoinformation tools are being used more for compiling data than for smart and timely decision making. The newly available tools will be effective to avoid loss and suffering only when the people looking at them are willing and able to really see what's there. It is about connections, not collections. We need to accelerate learning and dialogue on how to integrate what is known into what we do. Conventional approaches have led to slow change: too often we fail to avoid losses that are entirely predictable based on available data. We need to step outside of our comfort zone to help the humanitarian sector turn actionable geoinformation into action (see Figure 7). Participatory games can help.

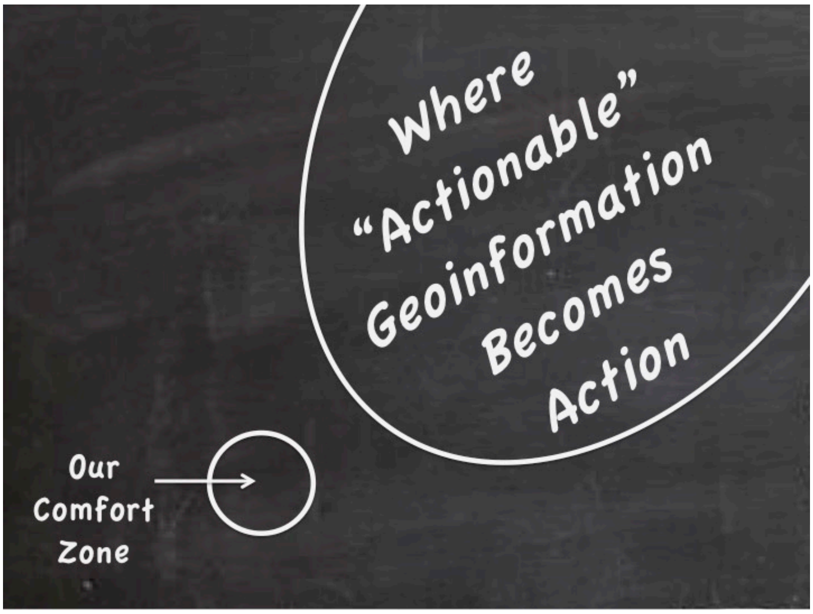

Figure 7. Humanitarian practitioners need to step outside of their comfort zone in order to turn allegedly actionable geoinformation into real-world action. Games can help.

Michelucci and Simperl [29], in their editorial on human computation (*i.e.*, approaches to understanding and implementing information-processing systems that combine humans and machines to achieve unprecedented capabilities), invoke two relevant quotes:

> *In the long history of humankind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed.*
>
> —Charles Darwin, 1859

> *The computer is incredibly fast, accurate, and stupid. Man is incredibly slow, inaccurate, and brilliant. The marriage of the two is a force beyond calculation.*
>
> —Leo Cherne, 1968

The humanitarian sector needs to fundamentally restructure its relationship to learning, evolving towards knowledge-based entities that can rapidly absorb and act upon the increasingly reliable information about changing risks. Inhabitable games and other interactive approaches offer much-needed impetus for motivating, accelerating, and consolidating a new culture of disaster management that embraces our capacity to engage with the world and its shifting, fascinating interactions in a new way. Well-designed interactive games can put us in the zone of productive disequilibrium.

Of course, games are not a panacea for infusing geospatial tools into humanitarian work: things can go wrong. The entire 16 pages of section 4 in the book "Games for a New Climate" [12] is dedicated to observed problems that can emerge in game-enabled processes, and ways to address emerging risks. Issues including inadequate simplification of real-world complexity, unskilled facilitation, ethical dimensions of authority and cultural diversity, and even an adult participant ending up in hospital with his ankle out of socket due to excessive passion among players competing for scarce resources. Designers and facilitators of game-enabled activities for spatial information must recognize that, like any new tool, games can do both good and harm—it is fundamental to invest time and attention in anticipating risks and ensuring a safe and productive gameplay experience for all.

This paper has presented an analytical framework describing why playable system dynamic models can immerse participants in an intensely interactive learning and dialogue experience that accelerates results. Two case studies have illustrated the possibilities of improving engagement, both in real-world crowdsourced geoinformation for flood forecasting for communities in sub-Saharan Africa, and in training government and civil society staff on open data for resilience. While of course much remains to be done to fully and rigorously examine the value and limitations of the proposed approach, it is clear that these endeavors represent first steps in the pursuit of an innovation that can help disaster managers further the understanding and use of geoinformation to support humanitarian decisions. The tasks ahead are massive; it is imperative to think ambitiously.

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Conflicts of Interest

The author declares no conflict of interest.

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