Serious Game Design for Flooding Triggered by Extreme Weather

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ABSTRACT
Managing crises with limited resources through a serious game is deemed as one of the ways of training and can be regarded as an alternative to a table-top exercise. This article presents the so-called “Operasjon Tyrsdal” serious game, inspired by a real case of extreme weather that hit the west coast of Norway. This reference case is used to add realism to the game. The game is designed for a single player, while the mechanics are framed in such a way that the player will have limited resources, and elevated event pressure over time. Beside applying an iterative Scrum method with seven Sprint cycles, we combined the development work with desk research and used the involvement of testers, including crisis responders. The resulting game has expected features and behaviors, is game(ful), but allow the player to learn through an “After Action” report that logs all player’s decisions, which is intended to trigger discussions.

KEYWORDS
3D Game, Crisis Management, Event-Based Game, Extreme Rain, Extreme Weather, Flooding, Game Development, Operasjon Tyrsdal Game, Resource Management Game, Training

1. INTRODUCTION
Extreme weather such as continuous rainfall over long period, heavy snow or heatwaves often comes as a surprise, even though emergency responders have received advanced and regular training. Unusual floods that follow extreme rainfall, or critical infrastructure dysfunction due to heavy snow can trigger chaotic situations. Weather abnormalities beyond usual patterns can also slow down emergency response, as the impacts often surprising and unexpected. Nowadays, there is increased interest in the usage of serious game (SG) for emergency management training, as reflected in scientific literature. It is deemed as a new opportunity of training for the emergency practitioner, volunteers and the public at large (Di Loreto, Mora, & Divitini, 2012). Using SG technique, one can generate various realistic, simulated, and hypothetical events in virtual environment for decision-making training under uncertain situations.

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The advantages of the SG approach for emergency management training has been mentioned in the recent literature (Brawley, 2015). Indeed, SG cannot fully replace field drills, but it can complement field training or be an alternative to table-top exercise. SG allows intended trainees (e.g. emergency management personnel and decision makers) to train more often than they otherwise would be able to do in field-based exercises. SG is a more affordable alternative for training activities, and cost-effective in the long run (Brawley, 2015). It can replicate conditions in various scenarios, allow organizations to record the exercises and logging the actions for later review, debriefing or repetition. Moreover, games are a less dangerous environment to train new personnel in, rather than exposing them to risk.

This background has motivated us to develop a 3D SG intended for decision-making training when a responder faces series of events occurring in extreme weather, as reported in this paper. The so-called “Operasjon Tyrsdal” SG is built by taking the extreme weather event “Synne” occurred in the west coast of Norway in 2015 as a case. The National Risk Analysis 2014 published by the Norwegian Directorate for Civil Protection-DSB (2014) confirms the importance of extreme weather such as heavy rainfall. It has been listed as one of six natural events that has the highest likelihood to occur and one that has the greatest societal consequences. Moreover, a national risk analysis document “RegnFlom i by” (Rain flood in city) (DSB, 2016) considers flood as a new scenario that the society should prepare for. In October 2017, two extreme weather events struck the South of Norway that caused flooding in some cities. These reasons justify the choice of scenario. It is worth to mention that the creation of this SG for training turns into a funded project KrisSIM which is supported by the local responder organizations as reported in this article (J Radianti, Martinez, Munkvold, & Konnestad, 2018).

Yet, as in other crisis scenarios, there are general, typical crisis situations where the emergency responders have limited resources, limited time to respond, and are often facing simultaneous events that need prompt responses. Sometimes, a decision maker has to make a priority, which event requires immediate actions, and which event can wait for further actions. Given all complexities in the real-world crisis and the principles of making serious games that need to be taken into account, then the main research question in this paper is: What kinds of serious game mechanics design can support learnable, playable SG for training in decision making and management of extreme weather events?

The contribution of this paper lies in our efforts on tailoring the real-world information of extreme weather situations and the game design principles into the “Operasjon Tyrsdal” game. Many actors need to collaborate in a crisis. The SG is designed as a single player game where the player is acting as an on-scene commander who is responsible for making decisions and managing resources in a crisis.

Two iterative phases of Scrum-based development were employed during the development process. The first Scrum comprised seven Sprints which were divided further into smaller technical development tasks, while the second Scrum, five Sprint cycles were implemented. However, in this paper, we only focus on the first Scrum results, but a summary of activities in the second Scrum is shortly introduced as well as a part for future development work.

To allow the involvement of users and local responders in providing feedback during the development process, the language used in the game is in Norwegian. However, for reaching out in the future, it is possible to translate all text and instructions in the game into other languages.

The paper is organized into six sections. After this introduction, the next section briefly presents reviews on related works and state of the art concerning serious game. Section 3 elaborates the scenario and the game design, while Section 4 reports the results or end-product, i.e., the “Operasjon Tyrsdal” game. Section 5 describes the Scrum method and the users’ role as testers in the game development process. Section 6 concludes the paper and reveal limitations and potential research directions.

2. RELATED WORK

Games approach with a stress on learning, participation, encouragement, and behavior improvement has been applied in many domains, and therefore repurposing games beyond entertainment is not
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