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Reply on RC1

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Author comment on "*Breaking the Silos*: an online serious game for multi-risk disaster risk reduction (DRR) management" by Marleen Carolijn de Ruiter et al., Geosci. Commun. Discuss., https://doi.org/10.5194/gc-2021-3-AC1, 2021

(Please find the attached PDF for a properly formatted rebuttal)

We thank the reviewer for their kind words. We fully agree that our study presents a preliminary data analysis. We did collect some qualitative feedback and have updated the manuscript with that. Nonetheless, the reviewer makes a very valid point, and, while out of the scope of this paper we will continue to collect and analyse feedback to keep improving the game into the future. We really like the suggestion of the reviewer to dive deeper into the behavioural aspect and to better understand how players made decisions to (not) interact with other players.

We agree with the reviewer that the description of the game mechanics is quite lengthy, and that a clear and brief explanation of the game mechanics was missing. In line with the comments of the other reviewer we restructured and rewrote the paper to better explain its emphasis on the development of the game. We did add the following at the start of Section 3 How to play the game:

[399] In *Breaking the Silos*, players are assigned their role at the start of the game. Before the start of the game, each player reads their role card, which provides them with detailed information about the DRR measures they can implement (these are unique for each role) and goals they need to meet. The game consists of three rounds. At the start of each round, the moderator selects a disaster and impacted area, and informs the team of the impact that the disaster caused. In each round, the team has a tight budget and time restriction to address the post-disaster situation and to prepare for a next disaster by implementing DRR measures. After each round, the moderator calculates the effects of the implemented DRR measures on the next disaster.

We agree with the reviewer that the main aim was not stated very clearly. We do not see this particular game version as a replacement to these other forms, but we believe that complementary forms are needed. We have adjusted the paragraph and included an explanation of the use of the RPG-game version in supporting our aim. That paragraph now reads as follows:

[90] To address the aforementioned gaps in current disaster risk serious games, we

developed the *Breaking the Silos* game. *Breaking the Silos* is a multiplayer role-playing game (RPG) that aims to raise understanding of the complexities of multi-hazard risk and asynergies of DRR measures among different DRM stakeholders. Solinksa-Nowak et al. (2018) argue that RPGs, more than other game types, allow players to directly experience the uncertainty, chaos, and stress of a DRM situation. Especially multi-stakeholder negotiation RPGs have been shown to be very promising in enhancing a player's knowledge of content and process (Rumore et al., 2016). In *Breaking the Silos,* the players are a team of different decision makers and stakeholders in the DRM process who advise the president of a fictional country on the implementation of DRR measures after different disasters, while considering potential (a)synergies of these DRR measures. The DRM process is mimicked by spreading knowledge and objectives throughout participants and by including randomness to the storyline. The game was developed to help various stakeholders (including policy makers, risk managers, researchers) better understand the complexities of multi-hazard risk and the potential (a)synergies of DRR measures. Unlike past games, this game includes multiple hazards and their spatiotemporal interactions. It also explicitly includes both the response and planning phase of the disaster risk cycle and promotes the examination of (a)synergies between different DRR measures. In doing so, we aim to create a game with a more realistic representation of the growing complexities of risk.

We thank the reviewer for this question. We realise we did not clearly state the actual playing time in Section 2.3. We have adjusted this accordingly. The actual playing time during the first round is 30 minutes, while the second and third round are 20 minutes each.

The temporal dimension of the game varies per scenario. Both for the time between events as well as the duration of the implementation of DRR measures we account for three different time windows: weeks, months, and years. We realized that this information was scattered over Sections 2.2 and 2.3. To clarify this and in line with a later comment of the reviewer, we have included a timeline showing both the physical time as well as the temporal dimensions.

The low-quality figures were indeed part of the initial draft document, and we have adjusted this in the revised manuscript.

We agree with the suggestion and have made adjustments accordingly. We have used the term "RPG" to refer to our own game and included a sentence in the introduction to explain the existence of different game formats, which makes it difficult to compare them.

[47] In recent years, a large number of serious games relating to DRM have been developed. Solinksa-Nowak et al. (2018) conducted a meta-analysis of DRM serious games and found that the majority focus on floods (27 out of 45 reviewed games), earthquakes (10 out 45), and droughts (7 out of 45), while storms (including cyclones, hurricanes, etc) are rarely the main hazards in a game (Solinska-Nowak et al., 2018). It should be noted that these games encompass a wide variety of game formats, including single- or multi-player video games, single- or multi-player tabletop games, and role-playing games (RPGs), making it difficult to compare them.

The randomness of selecting a hazard, hazard intensity, the size of the impacted area (number of cells), and duration between disasters was obtained by creating a random generator. In practice, this means that for each of these categories a random number is selected between the number of possible options. For example, for the hazard type a

number between 1, 2 or 3 is generated (using the integrated random generator function RANDBETWEEN) that corresponds to a tropical cyclone, drought or flood, respectively. For the hazard intensity, three levels are possible (1=low; 2=medium; 3=high), for the number of affected cells, it is an integer number between 5 and 15 cells. However, the exact location however is selected by the moderator. Finally for the durations between disasters and recovery time, three levels are possible (1=weeks; 2=months; 3=years) We have tried to explain this better by adding the following sentence:

[442] Before the start of the game, the moderator distributes the roles among the players, randomly selects a series of three hazard types (tropical cyclone, drought, flood), intensity (low, medium, and high) and time between disasters (weeks, months, years), and decides which parts of the board are impacted by the disasters. These selections are not shared a priori with the players and will define the storyline of the game. Each hazard type, level, and timescale have an equal chance of being selected (uniform distribution). Theoretically, it is possible that three of the same hazard types, levels, and timescales are selected. However, the chance of having three consecutive high intensity hazards of the same type for a storyline is 0.13%, but the number of cells impacted (5 to 15) and the location can still be different.

All players have a role card (an example of which is shown in Figure 1C) that describes in detail what DRR measures they can implement, what the conditions are (e.g., costs, restrictions in terms of location), etc. Aside from DRR-measure specific restrictions, there are no differences between the rounds in DRR measures that can be implemented. The only difference is that DRR measures implemented in round 1 are marked with a 1 and similar for rounds 2 and 3. This helps the Game Master identify implemented measures and see whether the construction of a measure is finished at the time of a new round. We try not to steer the players too much in their DRM behaviour, so we refrained from providing more detailed guidance on the decision-making process. We have added a brief clarification of this to Sections 2.2 and 2.3.

[412] Each of the role cards has the same structure (Fig 1c). It explains to the player the characteristics of their role including some background information about their position in the team, their relationship with some of the other members of the team, and the specific DRR measure(s) that their role can implement. It also provides some detailed knowledge on these DRR measures, including information such as their costs, their advantages, limitations and potential asynergies with other hazard types, the time it takes to implement them (discretized between weeks, months or years) and, depending on the role, information about particular hazards, demographic information, etc. Each DRR measure has a different symbol, and a numerical subscript is used to indicate the round during which these DRR measures can be implemented (Fig. 1c). The types of measures that a role can implement do not change per round, but some of the DRR measures cannot be built in particular cells of the map; for example, because they cannot be built together with another DRR measure or because they are invalid (e.g., a seawall can only be built in coastal cells), and some of the descriptions of DRR measures warn the player of potential (a)synergies (Fig. 1c). For example, the agricultural representative can plant both normal and drought-resistant crops (Fig. 1c). They have the following information: the costs of the different crop types (drought-resistant crops are more expensive than regular crops), drought-resistant crops are more vulnerable to floods, to meet the country’s needs they need at least 15 cells of crops, and neither of these crops can be planted in densely populated cells or in cells where Nature Based Solutions (NBS) have been built. The president, the national housing and urban development director, and the citizen representative roles have information about the population per cell. Conflicts can

arise when, for example, the citizen representative wants to implement NBS in the same cell where the agricultural representative wants to plant crops or if crops are in the downstream area from where the engineer wants to build a dam to decrease flood risk or upstream droughts.

[446] The moderator introduces the players to the overall game set-up and leaves some time for the players to read their role card to learn about their role and possible DRR measures that they can take during each round. They then read the background story to give all players' general information on the setting of the game.

The reviewer raises a very good point; we have included some detailed examples of DRR measures that players can implement as well as their possible conflicts.

[422] For example, the agricultural representative can plant both normal and drought-resistant crops (Fig. 1c). They have the following information: the costs of the different crop types (drought-resistant crops are more expensive than regular crops), drought-resistant crops are more vulnerable to floods, to meet the country's needs they need at least 15 cells of crops, and neither of these crops can be planted in densely populated cells or in cells where Nature Based Solutions (NBS) have been built. The president, the national housing and urban development director, and the citizen representative roles have information about the population per cell. Conflicts can arise when, for example, the citizen representative wants to implement NBS in the same cell where the agricultural representative wants to plant crops or if crops are in the downstream area from where the engineer wants to build a dam to decrease flood risk or upstream droughts.

We really like this suggestion and have included the following timeline in Section 3.2 Game play.

We thank the reviewer for their feedback and have rewritten the section as follows:

[47] In recent years, a large number of serious games relating to DRM have been developed. Solinksa-Nowak et al. (2018) conducted a meta-analysis of DRM serious games and found that the majority focus on floods (27 out of 45 reviewed games), earthquakes (10 out 45), and droughts (7 out of 45), while storms (including cyclones, hurricanes, etc) are rarely the main hazards in a game (Solinska-Nowak et al., 2018). It should be noted that these games encompass a wide variety of game formats, including single- or multi-player video games, single- or multi-player tabletop games, and role-playing games (RPGs), making it difficult to compare them. Djaouti et al. (2011) created a serious games evaluation system: the G/P/S model (gameplay, purpose, and scope). This model can be used to assess a serious game's main objective (i.e., training, message broadcasting, and knowledge exchange). Several studies have demonstrated the use of serious games in increasing risk awareness (e.g., Cremers et al., 2015; Mani et al., 2016; Mossoux et al., 2016; Pereira et al., 2014; Rumore et al., 2016; Solinska-Nowak et al., 2018; Taillandier & Adam, 2018). Rumore et al. (2016) quantified the effectiveness of serious games, and Role Playing Games (RPGs) in particular, in increasing risk awareness, where risk awareness includes risk literacy, an enhanced collaborative capacity to address risk, and social learning.

[92] To address the aforementioned gaps in current disaster risk serious games, we developed the *Breaking the Silos* game. *Breaking the Silos* is a multiplayer RPG that aims to raise understanding of the complexities of multi-hazard risk and asynergies of DRR measures among different DRM stakeholders.

We sincerely apologise for missing this paper earlier and we included it in the revised version.

We liked this suggestion; however, we also agree with a comment made by reviewer 2 stating that while Game Master would be correct terminology, "moderator" may be better understood by a wider audience. Therefore, we have added the following to the new Section 2.3 on the role of the moderator:

[199] The game requires a moderator, who can be thought of as a game master.

First, the players are asked to share their general thoughts on the game and then the game master asks the players to reflect on their decision-making process, and finally they are asked to compare the different rounds and discuss how their behaviour changed between rounds. Next, the survey is used as a more structured means of obtaining reflections that can be compared between different games.

We did not clearly explain this in the manuscript and have therefore included a new section on the reflections.

[212] **2.4 Learning through debriefing**

While often lacking, a debriefing element in serious games is of utmost importance to support the learning process (Crookall, 2010; Kolb et al., 2014). It is even argued that real learning comes not from playing serious games but from the debriefing element (Crookall, 2010). Several more recent studies have addressed this by including feedback on actions within the game, so-called "learning by doing", which can increase learning (Solinska-Nowak et al., 2018; Terti et al., 2019). Therefore, we decided to create three rounds, which demonstrate disaster and DRR interactions and allow players to change their approach to DRM in each round. Each round starts after a disaster and the team is asked to agree on the implementation of (a set of) DRR measures. We expect to see the teams responding to the particular hazard type that just caused a disaster rather than to also anticipate future risk of other hazards. Each round begins after a new disaster, and with the moderator explaining the impacts of that disaster as well as highlighting the impacts of DRR measures that were taken in the previous round. This intermediate debriefing that follows each round and is led by the moderator, was designed as such to enable a reflection on the effects of the actions taken, to allow players to adjust their behaviour in subsequent rounds, and to experience the effects of changing one's behaviour. We expect that this influences the team's behaviour during the next round. Finally, it was decided to include a discussion that takes place at the end of the game to enable players to reflect on the effects of the debriefings. The discussion can be supported by looking at the overview tables that summarize the actions taken after each round and the effects of these actions on subsequent disaster impacts.

We agree and have removed the sentence.

We have removed the mentions of “highly” here and in the conclusions.

The expertise of the players certainly plays a role, but it appeared that the group dynamics also play an important role. One of the main differences between the games played at UR versus the ones played with ETH Zurich is the difference in group dynamics: at UR most players did not know each other while at ETH Zurich, the players knew each other very well. Nonetheless, in all games, it appeared that during the second round, much fewer different types of DRR measures were implemented than during the first round. Moreover, the type of measures implemented also changed between rounds. We have expanded the analysis of the spending in Section 4.1, which now reads as follows:

[534] Even though the sequence of disasters and storyline were similar, the teams adopted different DRR strategies as shown in Fig. 3. This is also reflected in Fig. 4, which shows the different investments in DRR strategies between round 1 and 2, demonstrating the many possible choices and outcomes of the game, underscoring its high degrees of freedom. It appears that during all games, teams narrowed down the number of implemented DRR measures between round 1 and 2. While in round 1, on average teams implemented 7 different DRR measures, they implemented on average only 3 measures in round 2. Moreover, while in round 1 only one team invested in early warning systems for tropical cyclones and no one invested in dams, in the second round three teams invested in the tropical cyclone early warning system and two teams spent half of their investments on dams. We refer to supplementary material, Section IV, for a detailed overview of the coins spent per round, per DRR measure and per team.

This is a very important point. All players work in a field related to risk, with the vast majority working on DRR measures related topics. The players of the UR game came from a more diverse background compared to the players of the ETH Zurich games, but in both cases, roles were assigned randomly. We expected the expertise to be very influential in players’ decisions. However, our findings from our post-game survey show players working in DRR felt slightly better equipped to make DRR related decision in the game compared to players who work in risk but not in DRR. We therefore think a general background in DRR is of more importance to the game play than the specific expertise of a player. We have added a sentence to Section 4.2 to explain this better.

[666] During the post-game discussions, players’ different expertise within the field of DRR appeared to be of less influence on the behaviour of the player.

We thank the reviewer for her very kind words!

Please also note the supplement to this comment:

https://gc.copernicus.org/preprints/gc-2021-3/gc-2021-3-AC1-supplement.pdf