**Adventures in Model Land - BETA**

Models are a vital part of how the modern world works. Behind the scenes, in almost every aspect of society, they are quietly helping us make decisions. They do this by translating information we do have into the information we need to make decisions by using our knowledge of how systems work. For example, a model might translate observations of today’s weather into forecasts of future weather using our knowledge of meteorology.

A big problem that must be considered in those decisions is that models are not perfect replicas of the systems they represent, nor could they ever be. Natural systems are immensely complex and humanity’s collective knowledge of it is incomplete meaning even our best possible translations will miss at least some meaning and detail that prove important. Complex models too are difficult and expensive to build and operate, meaning we summarise some components to reduce that complexity.

By their very nature models are wrong. They are not able to give us a perfect translation or prediction of the future. However, a well-designed model, where its creator summarises only what they need to, and in the hands of a skilled operator who understands its limitations can be useful in guiding us to our best-informed decision. This is not always the situation we find ourselves in.

Thompson and Smith (2019)[[1]](#footnote-1) introduced the idea of ‘model-land’, further expanded in Thompson’s 2022 monograph, *Escape from Model Land[[2]](#footnote-2)*. Model Land is a metaphorical world created by the models we use to make decisions – it may appear to be identical to our, real, world yet its rules are different. It is the role of the decision-maker to understand these differences and make their decisions in the real world and not within Model Land.

Rather than escaping from Model Land, we invite you to adventure within. What if these metaphorical worlds were tangible, explorable worlds. What would it be like to put yourself in them, to walk around them, to live, eat, and breathe in them?

*Adventures in Model Land* is an open anthology of roleplaying games that explore the concept of Model Land. It includes a guide to building your world, which serves as a world-building game in itself, a framework to create both single and multi-player adventures, and a compendium of contributed games you can play.

We hope you enjoy!

**About**

Adventures in Model Land is an open-source, imagination-drive, and game-based framework designed to help you and others better understand your models.

**Open-source:** you are free to use this framework however you wish. Feel free to adapt it. Feel free to add to it. Feel free to turn it into a commercial workshop and start a business from it. The only requirement is you acknowledge the original source using the reference below[[3]](#footnote-3).

**Imagination-driven:** the engine that makes the framework work is your imagination and creativity. You need to create your Model Land and bring it to life. Imagination is a skill and one that can be practiced and developed. The better developed your imagination, the better your use of the framework will be[[4]](#footnote-4).

**Game-based:** the inspiration for the framework comes from games, in particular tabletop roleplay games (TTRPG), for example *Dungeons & Dragons*. In these games, new worlds are created and described by a Games Master (GM) before they lead a group of players on quests in this world. An alternative approach is for the players to create the worlds themselves. Games can vary in their level of fantasy, from using the real-world as a setting to high fantasy and science fictions settings.

Any work of fiction must create a world for it to exist in. Even when the real-world is that setting, it is never a perfect mirror. To support the storytelling, some elements are emphasised, and others are downplayed. Simplifications are made. Much of this is intentional but much is also due to positionality of the world’s creator – their biases, their interests, and their blind-spots. The mirrors that fiction show us are meant to highlight only some aspects of our world or the human condition – here the audience finds a truth in the fiction.

Are our models any different? This framework, by following through the steps it advises, will lead you into making works of fictions from your models. You will tell stories using them, from within them, and through these adventures you will see what is emphasised, what is downplayed, and where the simplifications are.

Ultimately, our aim for the framework is to provide you a tool for finding the truth and to defeat the fiction. Your aim could be to seek deeper understanding of your model or just to have fun. All are equally valid.

The framework in this document will lead you through three Levels.

In **Level 1** we create our Model Lands. This can be done as a standalone activity, by yourself, or with a group with you as a facilitator. It works best if you are a modeller and you work with a model that is familiar to you. By following a series of prompts, you define the rules of your world and begin to flesh it out, bringing it to life.

With your world created, you can move on to either **Level 2 or Level 3.** Currently, this framework only includes guidance for **Level 1**, with guidance for **Levels 2** and **3** to follow shortly.

In **Level 2**, you will use your world, and its rules, limitations, and opportunities, to create adventures and quests for a group of players with you as GM. Where the world building tends to emphasise the limitations and weirdness of your Model Land, your adventures will begin to reveal the ways the players can work with it, to find what is useful, to accomplish their quest.

Finally, **Level 3** is for those who want to take games that already exist and hack them to use the rules of your Model Land. How would *Settlers of Catan* play if it existed in a 2D hydraulic model, what would happen in a game of *Monopoly* if it had to follow the rules of an agent-based model? Answer these questions and make it playable.

Throughout this document you will also see vignettes – pieces of fiction, art, or examples of the framework being used intended to provoke and inspire your imagination.

Finally, as an open-source project we would love to see what you do with the framework and where you take it. On our GitHub page you can upload your examples, your adaptations, your expansions, and your vignettes, as well as find those created by others. Visit it here:

Adventures in Model Land has been created by:

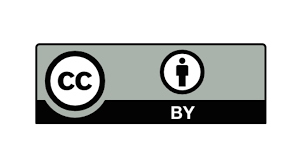
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**Level 1 – Creating a Model Land.**

This is a vignette. It is a short piece of science fiction that is creating a world that might help you with the task of creating your Model Land. It is a tool for you to use if you wish:

*By the year 2024, computer models had been embedded throughout every aspect of the modern world. Gymnasium-sized supercomputers produced weather forecasts that helped farmers know when to plant and harvest, cloud computing calculated routes and travel times guiding millions of drivers, and financial models predicted the future direction of the economy and determined decisions by the banks.*

*With the Covid-19 pandemic still fresh in the mind of governments around the world, the value of models as part of decision-making was cemented right at the top. The models gave the leaders clues about how effective their choices might be and let them claim they were “following the science”. However, the pitfalls of relying on models also became apparent when their predicted outcomes failed to precisely materialise. Were the models wrong? Or was the uncertainty inherent in the models not adequately communicated? Or did acting on the predictions change the predicted outcome in obvious or subtle ways? The models were needed but so was a way to better understand the information they were providing, and the leaders turned to researchers to solve this problem.*

*An unprecedented consortium from across the planet came together to find new ways to explore the limits of the models that predicted, and shaped, society around us. From this collection of multi-disciplinary talent came the ‘Thompson Dais’. A masterpiece of design, it used neuro-feedback technology, virtual reality, and haptics to place modellers within their creations, their own imaginations building the world around them. With their model brought to life they could invite others to enter with them, acting as tour guides to these strange alien worlds.*

*Little did they know about the adventures that would await for them within Model Land…*

Before you can go on an adventure, or lead a group of intrepid explorers, you first need to have a world to explore. It is time for you to enter the Thompson Dais and create your Model Land.

**Purpose**

In the same way as a good modelling project, an important first choice is answering the fundamental: “why am I doing this?”. Your Model Land itself is essentially a model of your model (and real-world interactions with it).

You can build a Model Land and attached game for wildly different purposes. One Model Land might be constructed with the intent to communicate the differences between model land and the real world and thus about the uncertainties inherent in models through playing in model-land. Another model world might be constructed to focus on the inner workings of the model. A single model can spawn many different Model Lands depending on the purpose, what is useful, and the different imaginations of their creators.

Finally, while all of the above hopefully lead to enjoyable experiences for the creator and players, it is absolutely valid to create a Model Land to just have fun in experiencing the absurdities found in models.

***This guide***

You will use your imagination to create your setting and build the realm, defining the rules and setting the parameters. The guide below is to assist you in doing this and it is just a guide – if you want to deviate from it, or embellish, we absolutely welcome this.

The guide is written with environmental models in mind that represent an area of the planet and subdivide time and space into discrete units. It may not fit well with other types of models. It will be useful for you to have a model project in mind too and by this we mean a combination of the numerical models (as a collection of laws, equations, and code) and the data to run it for that particular project (such as elevation data and timeseries inputs). We have also assumed a single deterministic model for the Model Land but adapting the framework for probabilistic models would be a fun challenge!

You will also need to get your imagination running and to be creative. When you’re ready, off we go.

The Ground Rules: You are you, and we anticipate that means you are human. We assume that your Model Land is habitable without the need for specialist equipment. We assume you can move and act just like you do in the real world.

**Defining the rules.**

The first step is to define the rules that bind your Model Land. We will consider the following things:

* Space
* Time
* Elements
* Parameters
* Life
* Inhabitants

Space: Consider how the space is divided in your model and how this might translate into your Model Land.

If your model uses a regular grid of cells or pixels, what is the resolution of them? Or, does it use an irregular grid? How does this make it look to you and affect the way you interact with it? Can people inside your model land move around within one pixel? Or can only one person inhibit a single pixel?

What is the extent of your model domain? What is at the edge? What happens if you go beyond the boundary?

Time: Consider how time progresses and is limited by your model and how this might translate into your Model Land.

Does your model have a timestep and what is it? Is it regular or does it change throughout a model run? How does this affect how you interact with the world? Are the people in the model also limited by the time-step? Or can the players / people experience time normally, but suddenly the world changes because of a new “time step”?

If your model has a defined end time, what is it? What happens to you if you are still in the model when time runs out?

Elements: Consider what the purpose of your model is and what things are being simulated in it. These things will exist in your Model Land.

What elements are you simulating in your model? For example, a hydraulic model will simulate water. Considering your rules about space and time, how would that element behave?

How would you interact with that element? How would the behaviour of that element appear in other contexts? For example, if the rules you apply to water in a river were transferred to water in a tap, how would that look?

Parameters: Consider how changing parameter values in your model would change the Model Land around you.

What are the key adjustable parameters that change the behaviour of your model? If they change, how would your Model Land adjust?

Are those parameters set before you enter or are you able to manipulate them in Model Land? How would you do this?

Life: Consider what life is like in your Model Land.

Does your model have any representation of plant or animal life or activity? What would this look like in Model Land? How does it interact with the other rules you have defined?

Do you want to introduce plants and animals to you Model Land? What would you add and how would they interact with your rules?

Inhabitants: Consider if your Model Land is inhabited by people (or other intelligent forms of life). These could be based on representations of people in your model or included just for interest.

Do you have people in your model? What rules do they follow? How would you interact with them?

If you add people, are they human? How did they get there? Do they exist outside of the Model Land rules like you, or are they bound by them? How does this affect how you interact with them? What are the social rules they follow?

**Designer Notes – Chris Skinner**

When I reflect on this world building exercise, I am reminded of how videogame developers create the worlds and levels for their games.

When I worked with BetaJester on *Flash Flood![[5]](#footnote-5),* a virtual reality game that visualised a real flood in a real river, we were converting a survey of a river valley into a game level for the player to walk around. Our world was finite and small, with a river that emerged out of nothing and flowed away into nothing. If the player walked off this edge they would fall into a virtual oblivion, with the bottom of the level disappearing to a dot as they fell.

To stop players falling off the edge of the virtual world, the developers added a glass wall – like an invisible force field that physically stopped them – a short distance before the edge. To mask the fact the river emerged and disappeared into nothing, they added bridges that hid these hard edges. In real life, there were no bridges.

A river running through a valley

Description automatically generated

A river running through a forest

Description automatically generated

**The real *Flash Flood!* valley, Thinhope Burn (top) and the virtual valley (bottom). The addition of trees and a mountainous background is a divergence from reality that made the interaction more interesting. It made the game a little more wrong but a little more useful.**

Similarly, there was a hard break between the edge of the map and the background. Trees were added to hide this break from view when viewed from most places in the map. In the end, we also added more trees to the map. In reality, there are very few trees at the site but they added a nice visual that made use of the virtual reality and encouraged the players to stay near the river where the action was happening.

When building your Model Land do not shy away from adding elements not seen in real life or in your model if they help you build your world or tell your story. But remember, just like when building a model, be careful not to let complex develop into complicated.

**Debrief**

With your Model Land created, there is now an opportunity to reflect on the world you have imagined and consider what it tells you about your model.

Start by writing a brief description of world to describe it for others. This could be in any form but writing it as a journal entry or as a travel guide might be a good way to go. Keep in mind how much your intended players already know about models in general and your model in particular.

Reflect on the following questions:

* How different is your Model Land to the real world? Did it seem alien to you and if so, how?
* What does this tell you about the assumptions in your model?
* Where is it closer to the real world?
* What would you now tell others about your model? What would you warn them about? What would you recommend?

**Adventure into CAESAR-Lisflood** by Chris Skinner

*Darkness. Deep, silent, inconceivable darkness. This was not just the absence of light, it was the absence of everything. Light, sound, life, gravity. I caught my breath, at least that I could do.*

*Streaks of piercing green light dissected the ceaseless void soundlessly. They came from behind, ahead, from the left and from the right. They shot like lasers without end, crossing one another at right angles to form a grid that spread into the distance, squeezing together into a horizon at the extent of my view. It settled beneath my feet and I found myself inside a single square of this nascent grid.*

*A ground began to form below my feet, a pale brown at first but swiftly deepened into a red sand. It felt like a relief to have my feet on solid ground again and the soft tug of gravity was like a hug from a well-missed friend. The stability was short-lived as the ground began to shift, the mesh stretching, twisting, and contorting as a topography grew out of the surface around me. At first it was smooth but as the valley sides formed around me as undulating slopes, each square of the mesh settled into a horizontal position, separating themselves from their neighbours. At the edges of my square, my current home in this strange land, were small cliffs with either a climb as behind me, or a drop as before me.*

*The silence was suddenly disturbed by a cascade of echoing crashes. The ground shook as the rumbles of what I assumed was a series of landslides afflicted the landscape simultaneously. Then, as quickly as it started it was over, and silence once again dominated the world.*

*As the stillness settled, I explored my home square. Despite the blockiness and stepped nature of the landscape around me I could recognise my location as the floor of a steep sided valley, possibly even in the river bed itself. I paced out eleven steps across from one side to the other and guessed the width was an exact ten metres. I looked around and every square appeared to be the same exact ten metres wide.*

*I left my square, scrambling over the small cliff that came up to my knees between it and the one that was originally behind me. I made for the valley side, wanting to get a better vantage to survey my surroundings. Some cliffs required me to drag myself over them, whilst others were so tall I had to find routes around them as I made my way up. From the top I could clearly see the river channel below snaking its way down the valley, its bed drive and sandy red. I could see the hills raise off in one direction, and the land drop away into the pitch-black sky in the other. As far as I could see, each square was the same apart from its elevation. The surface of each was the same sandy red, with a smattering of larger pebbles and rocks, with just a few larger boulders. They were embedded into a perfect flatness.*

*To my surprise, rain began to fall from the cloud-less, colour-less, anything-less sky. The drops were a uniformed size, each a small cube of solid light blue. Where they collided, with either me or the ground, they vanished and left no wetness. It struck as strange too how it immediately began, rather than built up, and I was instantly surrounded by a curtain of rain. As I looked around, the rain was spread equally as far as I could see.*

*Suddenly and after a few minutes had passed the strength of the rain changed, noticeably getting heavier. The rain had also begun to collect on the ground, with pools of blue emerging out of nothing in depressions. I checked my watch to time and it was five minutes before the rain changed again and the pools got deeper and began to join with those in neighbouring squares, the form of the river beginning to appear.*

*I continued to walk along the top of the valley towards where I thought the outlet would be. As I went, the rain changed several times and as it got heavier the time between the changes getting increasingly shorter until it was just merely a second. I could see the flows, although stuttered, almost resembling the rivers I would recognise. As I looked I noticed the colours of the water was varied, with the light blues giving way to deep purples and bright pinks and I assumed these were the areas of deeper water.*

*The endless black beyond my current plain of existence came into view and I saw what must have been the catchment outlet. I dropped back into the valley, hopping down the shallow cliffs between the squares, and approached the edge. I walked alongside the river, its flows contained within a channel a single square wide, I lay on my stomach and inched towards the edge. I stared into the endless abyss once more and felt queasy at the thought of tumbling over. Below the ground were clear layers of land that had the same colour as the ground and seemingly matched its patterns of sand, stone, and rocks. Beneath them, was a layer of solid granite grey, about a square’s width down, that stretched into the void below. As a pulled my gaze back, I expected to see the water drop like a waterfall off this edge but instead it hung on an invisible square beyond the realm before it simply vanished.*

*I stood again and turned to take in the scene around me. The rain was heavy and obscured my view and the flows still progressed incrementally. With each one second step as the water marched on, it was accompanied with cracks, crashes, and rumbles.*

*Eventually, the rain eased off and stopped. The flows followed soon after and settled again into progressing every five minutes. As the water receded, I observed the changes wrought on the ground – where flows had been, especially in the areas of purple and pink, the uniformed coverage had changed, now being covered in less sand and more stones, with the squares next to them the opposite.*

*I decided to leave at this point. This world was too alien for me and it made me uncomfortable.*

CAESAR-Lisflood is a model we use to help us understand the way the surface of the Earth changes. It simulates the processes of hydrology and geomorphology, mainly the ways water flows erode and deposit sand, mud, and stones. Importantly, models like these have to simplify the immensely complex processes involved and there generally is not enough data to check if they are accurate, so we do not (and should not) use them to make predictions about the future.

The model land I imagined is based on a simulation of Tin Camp Creek in Australia I used in Skinner et al (2023)[[6]](#footnote-6). Some of the model details I tried to get across were:

The heights of the land surface were represented by a grid of ten-metre-wide squares, called cells, each of the average height of the land across that cell.

* The distribution of grain sizes, the sand, mud, and stones that make up the land, was the same in every cell to start with.
* I did not have any representation of plants in this model but you can do this in CAESAR-Lisflood.
* The bedrock layer, which cannot be eroded and is essentially the bottom of the world, was set at ten metres below the starting surface.
* Landslides occur in the model when an angle greater than 45 degrees exists between neighbouring cells. Usually when you start the model, a whole bunch of landslides happen at once.
* Rainfall was ‘lumped’, meaning if it rains it rains the same amount everywhere.
* The model uses a variable time step. This is how it averages time – when there is little or no rain it will use a larger step to average, up to five minutes. When rain and flows are higher it is more likely that erosion and deposition will occur, so it averages over smaller steps to capture the detail. This helps the model run quicker by skipping over boring periods.
* The graphics of the model uses blue to purple to pink to represent the depths of water (or other aspects you can look at, including velocity).
* Nothing exists beyond the realm of the model domain you set and flows will just vanish into nothing. However, you set an angle for flows exiting the model, otherwise you get excessive erosion or deposition at these points.
* The river flows change the shape of the land and the distribution of sediments in each square.

1. Thompson, E. L., Smith, L. A., 2019. Escape from model-land. Economics. 13(1). DOI:10.5018/economics-ejournal.ja.2019-40 [↑](#footnote-ref-1)
2. Tompson, E. L., 2022. Escape for model land: How mathematical models can lead us astray and what we can do about it. Hachette, UK. ISBN: 1529364906, 9781529364903 [↑](#footnote-ref-2)
3. Skinner, C.J., Thompson, E. L., Lewis, E., Hut, R., Illingworth, S., 2024. Adventures in Model Land Framework: Version XX. DOI: XXXX [↑](#footnote-ref-3)
4. And it will make you a better modeller! [↑](#footnote-ref-4)
5. Skinner, C., 2020. Flash Flood!: a SeriousGeoGame activity combining science festivals, video games, and virtual reality with research data for communicating flood risk and geomorphology. Geoscience Communication, 3, 1-17, DOI:10.5194/gc-3-1-2020 [↑](#footnote-ref-5)
6. Skinner, C. J., Coulthard, T. J., 2023. Testing the sensitivity of the CAESAR-Lisflood landscape evolution model to grid cell size. Earth Surface Dynamics, 11, 695-711, DOI:10.5194/esurf-11-695-2023 [↑](#footnote-ref-6)