

## 1. [SLIDE 1]

This project is about exploring the use of a microworld to teach about economic viability of climate aware forest management.

## 2. [SLIDE 2]

Climate change, the role of forests as carbon sinks, and spreading awareness about challenges around combating climate change while maintaining economic viability comprise the premise of this project.

3. [SLIDE 3]

This has been a year of unprecedented heat in many parts of the world. In addition to extreme weather and a negative impact on health of most living things, rapid climate change and global warming also disrupt our key industries.

As many of us are aware, carbon dioxide in the atmosphere is a key driver of global warming. CO<sub>2</sub> is an important greenhouse gas. It helps keep the planet warm enough to make life possible.

But in a very short time since the industrial revolution, human activities have released a very big amount of carbon into the air, and this has led to current atmospheric CO<sub>2</sub> concentration being higher than ever before in over 800,000 years as you can see here.

In 2023, the concentration was 419.3 parts per million (ppm). On 22 June 2024, this was 427 ppm. It was predicted that if CO<sub>2</sub> levels rise to 430 ppm, then we will experience widespread dangerous weather conditions and this year seems to reinforce this.

So, there is an urgent need for action against climate change.

Forests are crucial to fighting climate change because they currently absorb around 30% of global emissions. But they are also fragile. If enough of a forest is cleared, they begin to release more carbon than they absorb and given our high demand for wood, this is already beginning to happen.

So once again, spreading awareness about the importance of maintaining our forests as carbon sinks is crucial to ensuring a sustainable future and is therefore in alliance with goal 4 of the Sustainable Development Goals by the UN which is around "Quality Education".

4. [SLIDE 9]

Mycroforest is the application that this project presents.

There are many existing similar tools as listed along the top of the table here.

Along the side of the table, are qualities that these other tools as well as Mycroforest is scored against.

Many apps are very scientifically accurate decision-making tools like foster forest aimed at experts or adults.

Mycroforest is not like this because the underlying conceptual model for teaching about forest management, does not have to capture plant growth and the carbon cycle in extreme detail. It uses a simple, yet reflective model of the real world. This is just like some of the other similar tools like Mine Set or About That forest.

As far as this project is concerned, Mycroforest ticks all important boxes.



It is an engaging, easily accessible web-based application aimed at the youth.

Although the app itself is not multiplayer, it still allows for team learning activities in addition to individual ones.

Unlike many tools that tackle multiple problems at once, Mycroforest focuses exclusively on forest management, it's effect on atmospheric CO<sub>2</sub> concentration and the impact of financial motives.

This app is built to be easy to get into and use with lots of built-in help.

There is a slide for each of the 4 other apps which we can look at after this presentation if you'd like that.

5. [SLIDE 10]

Myroforest is a “microworld”. This is to promote learner engagement and constructivist thinking which have both shown to improve learning.

It's graphical feedback with short explanations should also improve learning effectiveness. But since microworlds have proven to be most effective only when some structure or guidance is provided, it's intended for this app to be used by students in the presence of a knowledgeable facilitator.

The app allows for setting of some targets around which structured learning activities can be developed and challenges that students can attempt in teams. This makes for a motivating, game like environment.

The students can then, discuss about what they've learnt after each challenge.

The app also allows for complexity to be built up progressively in stages so that it's easy to get started.

6. [SLIDE 11]

Now, let's explore what's possible using the MycroForest app.

What can you, as a learner do, using Mycroforest.

To begin with, you receive your own forest with 2 species of trees at different stages in their lives.

You can create forest management plans by deciding when and how often to plant or fell a tree.

You can also move across time using the timeline and view your plan in action.

Chopped trees are sold for timber and this fetches income in coins.

You may earn through other income streams like by selling non-timber forest products or by opening the forest up for public recreational use.

It is also possible to introduce emissions due to fossil fuel usage.

You can view your back balance, expenses, and income, as well as atmospheric CO<sub>2</sub> levels that change over time.

Finally, the target setter allows for you to set CO<sub>2</sub> and income targets while also showing whether you've met them.

7. [SLIDE 12]

Now, we'll look at the tool's design as it is now.

Under the hood, the app can be thought of as being composed of a simulation, UI components, and input variables along with some common utility functions that are accessible from every project file.

It contains 4 pages.

The landing page is the first thing the learner sees. It's got a short introduction that the user can click through which provides information regarding what the tool is about.



Pressing H on the keyboard will reveal a help page with all the components of the world, what they mean, and how to use them.

Pressing the W key will take the learner to the main world page.

Here, the plan button can be used to view the planner page through which management plans can be created.

8. [SLIDE 13]

From conception to fulfilment, the design and idea for this tool have been through multiple changes. This is an example of some of them. They'll be detailed in the dissertation writeup.

The next 3 slides will show 3 designs along the way before the final version that we just saw in the previous slide.

9. [SLIDE 14]

This was the first power point mockup of the app. It was much more cluttered compared to the current app and had a less intuitive way of capturing amount of wood harvested.

10. [SLIDE 15]

This was the first working web version of the app. It was built to experiment with the graphical representation of tree growth and to judge if it was feasible to use the selected technology or not.

11. [SLIDE 16]

This was the last animated prototype with all features built using the Figma platform. The final app looks a lot like this mockup.

12. [SLIDE 17]

Here we move on to how the app was built.

MycroForest was built using the NextJS framework. Next.js is a React framework that enables optimized server-side rendering, static site generation, and simplified routing for building web applications fast.

MycroForest is hosted on Vercel. Vercel is a cloud platform where web apps can be deployed. It was created by the creators of NextJS and hence the two are very compatible.

Moving a layer deeper, ReactJS is a JavaScript library for building user interfaces. It allows creation of reusable UI components and makes state management easy with efficient virtual DOM manipulation.

At the core is HTML, CSS and JavaScript, the trinity that the web is built upon. HTML provides structure, CSS adds style and JavaScript brings dynamism. Everything else exists to make development using these primary languages easier.

Towards the side, are listed libraries/frameworks that further enhance or simplify development.

D3.js is a graphics library. In the app this was used to create the very customized piece of land where trees grow and change shape.



Tailwind CSS is a framework that integrates CSS into HTML for ease.

The file-saver.js library was used to allow user plans to be saved and reloaded.

The Big.js library helped overcome the challenge of precision loss when working with astronomically large numbers, and the react-tooltip library provides a ready-made tooltip component that is otherwise cumbersome to build from scratch.

13. [SLIDE 18]

Bad code has the following 4 defining characteristics.

It is difficult to change, prone to breaking, difficult to reuse, and contains hacks instead of appropriate fixes.

While developing Mycroforest, measures were taken to prevent such consequences of bad design.

The code adheres to the model view controller design pattern and the underlying model is organized in an object-oriented way in classes.

Every new feature was well tested before integration.

Web pages are composed of reusable React components, and temporary fixes were largely avoided.

This is a glimpse of Model View Controller separation in code.

The model captures simulation logic and rules while the view is what is returned to the screen and the user sees.

The code above the return statement in each component can be considered as the controller, which is the intermediary between the model and the view.

This is a quick look at the UML class diagram that captures the simulation model in an object-oriented way. Details can be found in the writeup.

14. [SLIDE 19]

Development itself followed an Agile management strategy.

It was an iterative process comprising 3 broad stages; namely planning, building and deployment with research conducted as and where required.

Typically, an iteration would involve a whiteboarding phase followed by more concrete visualization and then coding stage.

This workflow allowed for frequent delivery of features.

Features to be implemented were broken down into small parts and added to a list somewhat like a product backlog and was checked off after implementation and testing.

GitHub was used for version control, and it was linked to Vercel to set up the continuous integration and continuous development pipeline. Every time a new feature is pushed to GitHub, it a new version of the app incorporating this change is deployed.

15. [SLIDE 20]

This slide presents some problems faced and solutions identified. Once again, you may find details in the writeup.

But, for example, a simple, yet important problem was that of organizing all the data and rules that make up the simulation model. I found that a good solution to deal with confusing interconnected ideas, was to adopt network-based file management for which a Software called Obsidian was used.

Each node in this image representing a key component or idea within the model. Clicking on it opens the corresponding file with all logic related to that idea.

The connections show how these elements fit in with others and this, I found, greatly helps organize things in the mind.

16. [SLIDE 21]



Now, let's check out the deployed app.

I believe the best way to get a feel for it is to quickly go over few challenges just like students would.

17. [SLIDE 22]

As for evaluation, the Mycroforest teaching tool was used for a 2-hour session with 10 Transition Year students on the TAP Bridge2College Program.

The session began with a quick introduction followed by 2 challenges. Each challenge was followed by a discussion. At the end of all activities, the students filled in a feedback form with questions on user experience, educational value, and attitude towards climate change.

18. [SLIDE 23]

Most students had positive comments.

They appreciated the ease of use and information presented.

They suggested that more scenarios be included, and that help be made clearer.

The Botany professor, a domain expert, pointed out how the students had discovered for themselves, two existing forest management strategies called "clear felling" and "thinning".

Overall, from what the students reported, they left the experience with greater awareness and appreciation regarding the need to reduce CO<sub>2</sub> in the air, manage forests sustainably, and the need to find a middle ground between economic gains and health of the planet.

19. [SLIDE 24]

Throughout this project. I myself have learned a great deal about forestry and what goes into creating an effective learning application.

I've also furthered my web development skills and got to employ concepts learned in my Advanced Software Engineering module during development.

It was most exciting to have real users evaluate the application.

20. [SLIDE 25]

Overall, I am satisfied about how this project has led to the development of a functional teaching tool that students and teachers liked.

I am happy to have furthered my research and web development skills and am very grateful for the opportunity to help in sharing knowledge.

A key limitation of the evaluation was that it was possible to have only 10 students try the app so far.

So, an extension of this work could involve trying it with more students and trying to make the model more stable or accurate.

Also, a built-in interactive tutorial tour could be developed to help users get a feel for the tool quicker.

Lastly, the tool could also be extended to include more income streams like agroforestry and management actions around disease control, fire prevention, etc.

21. [SLIDE 26]

Thank you very much for your time.

Please feel free to ask any questions  
or share your thoughts on this  
project.