**SPEECH LAYOUT**

**Introduction Us and Problem**

* Introduce team – we are CORE and international company that focuses on projects by consulting, optimising, revolutionising and executing solutions for our clients.
* Four months ago GHD advertised the issue of waterway contamination from an historic landfill site located in Mackay. This landfill site
* Environmental protection act
* Why do we need to model it: landwater model is vital because of

**Model (2mins)**

* Richards equation
  + Coupling with..
* Outline evotranspiration
* Rainfall input
* Cjrea

I’d now like to introduce Zander to discuss how we implemented these conditions into our chosen software.

**Computational Model (3-4 min)**

* Thank you Laura, using matlab we …
* Why is the model efficient? <- focus question!!
* No for loops
* Adaptive time step

I’ll pass you to Olivia to introduce how we incorporated rainfall data specific to Mackay

**Bucket Problem and Model Validation (1-2 min)**

* We modelled the implementation of our solution based on the analytic or expected solution
* The bucket problem disregards the more complex conditions and assumes no outflow at the boundaries and that the bucket is homogeneous meaning its made up of only one material. – also show drought year for hetero mesh
* The only condition introduced is the rainfall coming in from the top of the bucket.
* As seen in the graphs the model is valid ….
* Now that the model has been validated we can reintroduce this to the heterogenous problem with multiple different materials and boundary conditions

**Climate Model**

Thank you, Zander,

As the computational model was being created our team was able to work simultaneously on the rainfall model. Ten years of rainfall data was gathered from the Bureau of Meteorology using a weather station nearby to our landfill in Mackay. The rainfall model used data ranging from 2011 to 2020 this was to encapsulate a wide range of years to gain an accurate dataset **(show figure)**. When reading this data into our software it was found that there were some days in which the weather station did not record the daily rainfall. For these blank entries we decided to take an average of the rainfall on this date for all other years which recorded data and use that average as the value of the missing day. Now that the data was checked for completeness and any inconsistencies filled in, we used this data to create the rainfall models.

Analysis of the effect of extreme weather events on the model were done separately so for the averaged data 2011 was excluded due to the floods **(show figure).** The averaged data was to used to model a constant and cosine function as you can see here. The overall daily average calculated was 4.2 mm/day, this was used for the implementation of the cosine model. As seen in the averaged plot Mackay sees a spike in rainfall for the first roughly four months of the year this then reduces significantly for the six months that follow before increasing again by the end of the year. The limitation of this model is that it fails to capture these significant peaks and dry periods as it has instead averaged the data. The Fourier series approximation, however, takes a dataset and approximates it to produce a plot which follows closely to the given rainfall data as seen here. The benefits to utilising the Fourier model is that it can accept any dataset.The main limitation of this model is that since it uses sine and cosine functions the Fourier approximation during periods of little to no rainfall oscillates below zero. Since Mackay exhibits long periods of no rainfall it was reasonable to set any subsequent negative rainfall to zero.

A cosine approximation of the 2011 data was then used to model flooding as seen here. **Show slide.** Where this used an average of the flood year data which increased the average rainfall from 4.2 mm/day to 5.1 mm/day. The averaged value 5.1 was used as a more accurate Fourier approximation of this flood year proved to be too much rainfall intake for the system to run, this is a limitation of our current model, and it will be improved on. Another extreme weather event are drought, for these periods the model was simply given zero rainfall, since the model is looking at the movement of ground water the effects of drought were insignificant so focus on modelling for wet periods was found to be more important.The analysis conducted will consider these differing rainfall conditions to determine how the groundwater will move based on each condition.

To further investigate the climate in Mackay, Markov chains were used to compare the probability of rainfall. This was done for the averaged data and compared to the year where Mackay experienced flooding. As seen here the probabilities for 2011 show that there was roughly 62% chance of rain and for the averaged data there was only 19%. This is an overwhelming difference and supports the need for an adaptable model which can solve using various climate conditions.

**Analysis**

Now that we have the solution implemented into MATLAB, validated and relevant rainfall data inputted the effect these different rainfall models have on the system could be analysed. As seen on the figure here we can see time on the x axis in days running up to day 600. On the y axis we have the average water content. You can see that each curve reaches a steady state value, at this point the system is 95% saturated meaning it can no longer accept rainfall input. This means that evapotranspiration will still occur which will reduce the saturation below 95% which then triggers the rainfall again. Once the system has reached 95% saturation the small oscillations of the evapotranspiration and rainfall are seen here for example. Each curve begins at the same point but as the system runs reaches the steady-state average water content at differing times. This is because each model is inputting a different value of rainfall per day. The cosine models are the slowest to reach steady state where the averaged data reaches 95% at day 287 and the flood year cosine reaches at day 249. In the case of more accurate flood data this number would be a lot lower however, you can see the difference between these two models and the effects that severe weather events have on the system. Following the cosine models the constant rainfall took 231 days to reach steady state this is simi which leads to the fastest model to reach steady state the Fourier approximation. This model took only 73 days to reach 95% saturation and is the most accurate reflection of the rainfall in Mackay

I will pass you to Laura to continue the analysis.

* Location of water table – evident that it remains roughly 2-4m below the landfill surface. Hence Fourier climate model was considered for the rest of the analysis (in the interest of time) . PM
* Benzene creek outflow based on range of Kc values
* Increasing evaporation rates in different sections (showing what an evaporate cap would do) – research plants that can result in greater evapotranspiration
* How changing the evaporation rate changes the water table 🡪 increasing evapotranspiration will lower the water table
* Provide recommendations on monitoring stations/evaporative measures if necessary
* Limitations of model (it is important to be transparent that there are limitations to the model) – there are tradeoffs

**Project Management (3-4 min)**

* Overview of approach to project – include animation thing that liv mentioned on the PPT
* Include PBS,WBS &OBS – established stakeholders
* Maintained good group dynamic – constant communication (met at least twice a week)
* Lessons learnt
  + Computational model took longer than expcted to implement – analysis when quite smoothly subsequent to its implementation
  + Previous experiences together, we knew where to allocate peoples roles as we knew peoples strengths/weaknesses. – we were also able to redelegate tasks along the way
* Quality assurance – drive home bucket problem validation/heterengous model also validated by project sponsor
* Risk impact – covid (one week of isolation)
* Not afraid to ask for help (very inclusive/positive environment)
* Iterative approach
* Time management – met up twice a week – progress was made every week as a group, we used github as a filesharing mechanism to be able to see edits that had been – we were constantly in contact with each

**Conclusion and Recommendations (1 min)**

* Recommendations (limitation doesn’t properly account for flood year – this can be further investigated if you are hired)
* Evaoprtaive cap (provide summary

Thank you listening to our presentation, are there any questions regarding our model or anything we can clarify further?