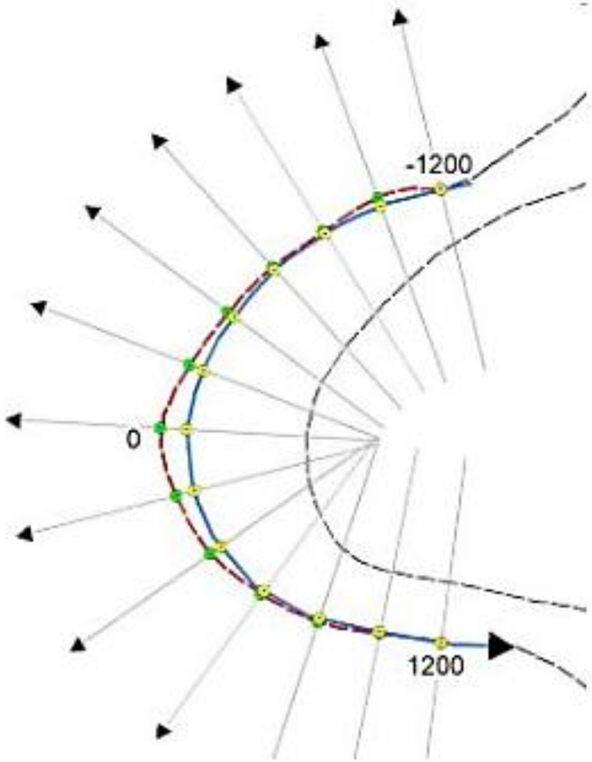
User Manual of Riverbank Erosion Prediction using Hasegawa Model

Developing an Application (App) on Erosion Prediction using Kazuyoshi Hasegawa's (1989) Model

This notebook implements the erosion prediction model proposed by **Kazuyoshi Hasegawa** in 1989. The model uses a multitude of parameters governing erosion to predict the extent of erosion in meandering bends. By following the steps below, you can input data and get predictions based on this model.



An App (Executable File, .exe) has been developed from the Python script. The Tkinter library has been used to create a user-friendly interface (UI). This interface enables seamless application of the model, allowing users to input various parameters interactively and customize the model according to their requirements.

Kazuyoshi Hasegawa's Model Workflow

Equation of Bank Erosion Rate

$$\xi = \sqrt{C_f} \times I_0 \times \left[\frac{3KT\tan\theta_k}{(1-\lambda)(\frac{\rho_s}{\rho}-1)\sqrt{\varphi_*}}\right] \times u_B$$

- Uinf= Mean flow velocity in straight channel along valley axis (m/s)
- Hinf= Mean water depth in straight channel along valley axis (m)
- H0= Mean channel water depth (m)
- n= Manning's coefficient
- I0= Longitudinal bed slope
- U0=(1/n)*(H0)**(2/3)*(I0)**(0.5)
- σ= Phase shift (m)
- B= Channel width from satellite image (m)
- g= 9.81 m/s^2
- R = Radius of Curvature (m)
- K= Coefficient in bed load function
- T= Average transverse slope angle of concave bank
- tan(θk)= Average transverse slope angle of concave bank

- λ= Porosity of bed and bank material
- ρs= density of sediment in kg/m3
- ρ= Density of sediment in kg/m3
- sg= Specific gravity in m/s2
- D50= Mean particle size (mm)
- I0= channel bed slope
- φ*= (τ*)/(τ*- τ*_cr); where
- τ*= (H0*I0*1000)/((sg-1)*(d50))
- τ*_cr = Critical Shear Stress

Major Steps in Setting up the Hasegawa's model

Step-1: Analysis of Hydro morphological Data & Input parameters consideration

Step-2: Extraction of river Bankline and Average width

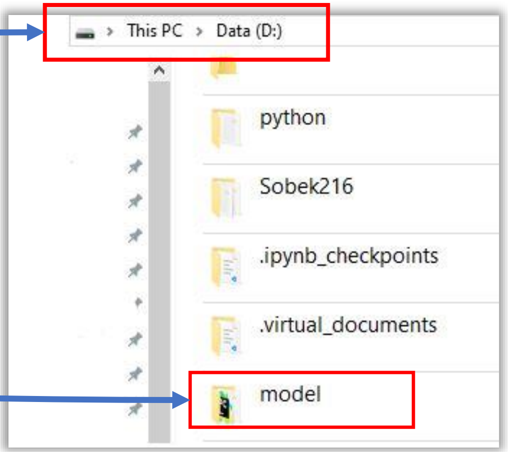
Step-3: Creating erosion calculation points and establishing streamwise coordinates

Step-4: Calculation of Radius of curvature and near bank excess velocity

Step-5: Erosion prediction and visualization

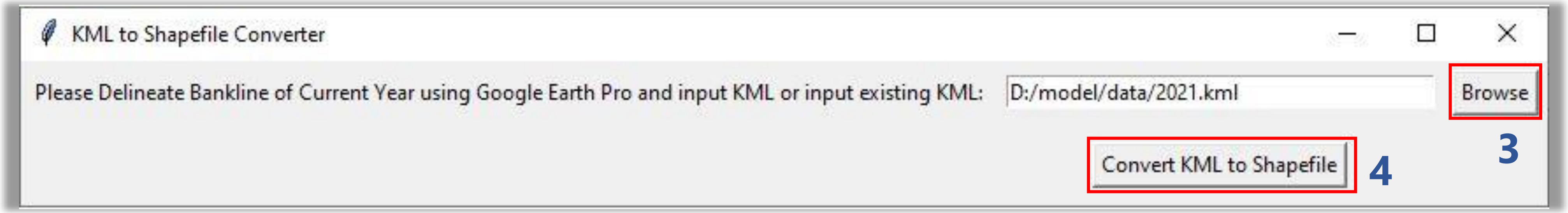
Step 1: Copy Data & Run the Model

1. In the address "**D:**" of your local computer, Copy the folder named "**model**".



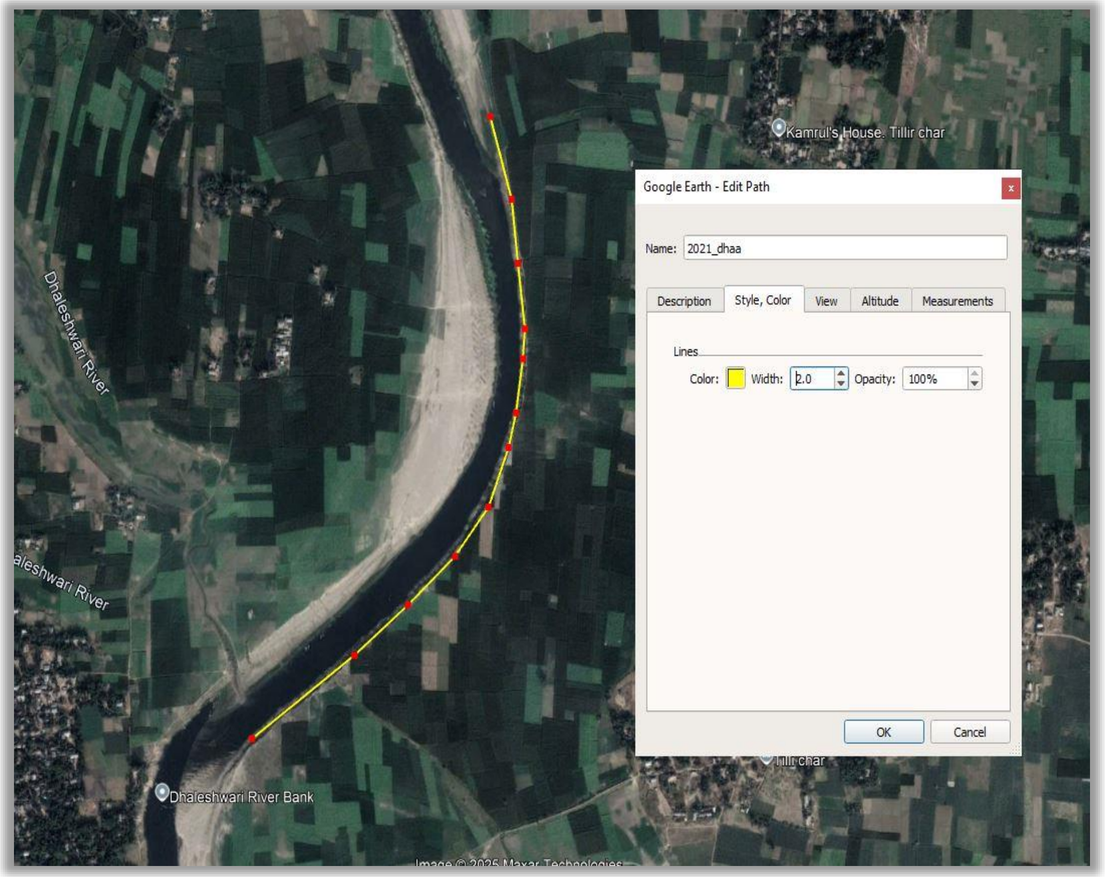
2. Navigate inside the "**model**" folder and double-click the **.exe** file which will execute the model

Step 2: Draw KML and convert to Shapefile



1. The model will prompt the user to open Google Earth Pro and draw the bankline for the current year.

2. After delineating the bankline, save it as a KML file in the “**data**” subfolder inside the “**model**” directory

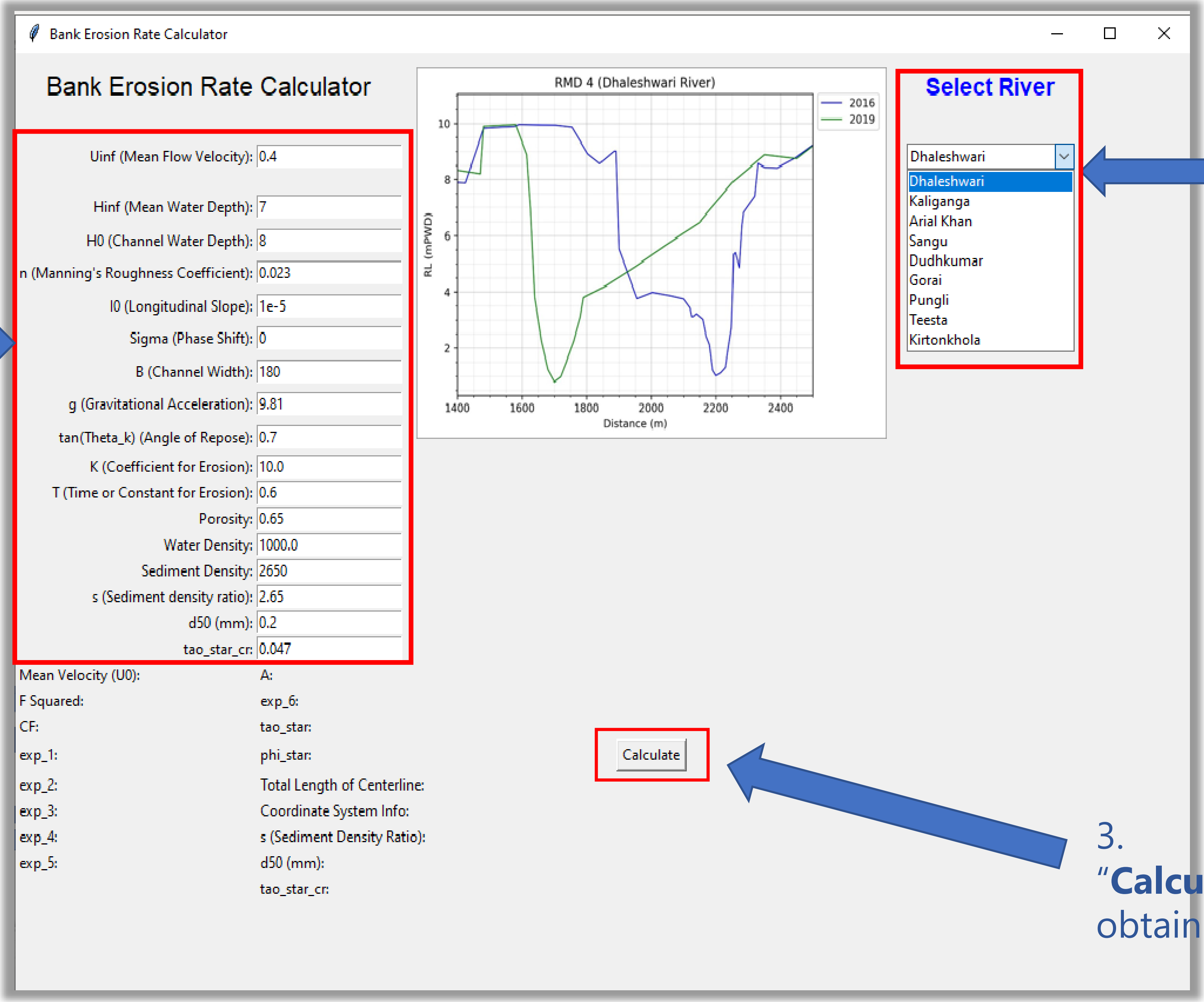


3. Next, click the "**Browse**" button and select your saved KML file.

4. Click "**Convert KML to Shapefile**" to convert the file for processing.

Step 3: Input Required Parameters

2. Input Hydro-morphological, Geotechnical, and Environmental data as per model requirements for that particular bend



1. Select the Target River from the Dropdown Menu

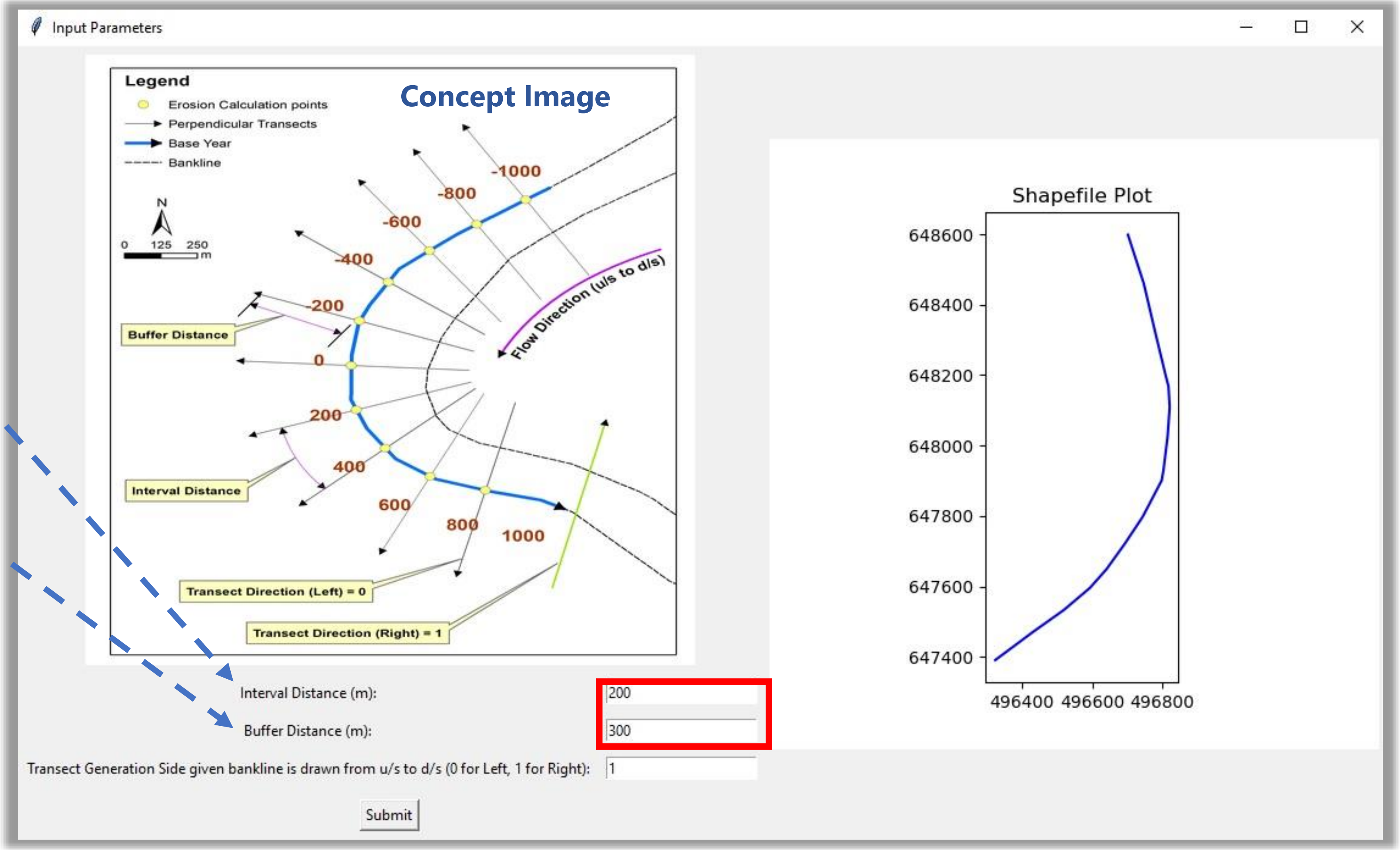
3. Click the "**Calculate**" button to obtain and save results

Step 4: Set Data Generation Resolution

Define Transect Generation Intervals and Buffer Distance

1. **Specify** the Interval Distance (m) for the generation of perpendicular transects

2. **Set** Buffer Distance for the transect length

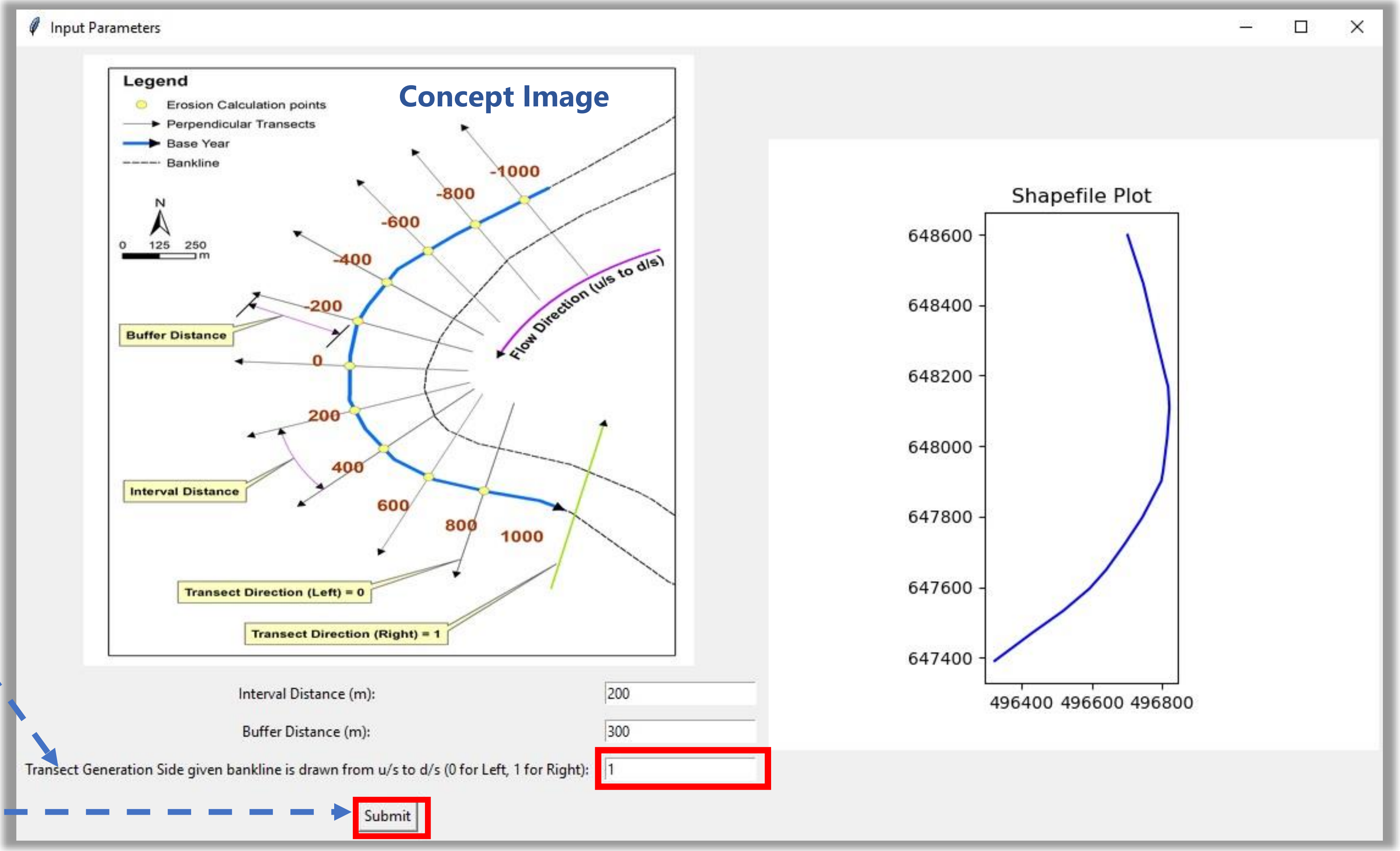


Step 4: Set Data Generation Resolution (Contd…)

Define Transect Generation Intervals and Buffer Distance

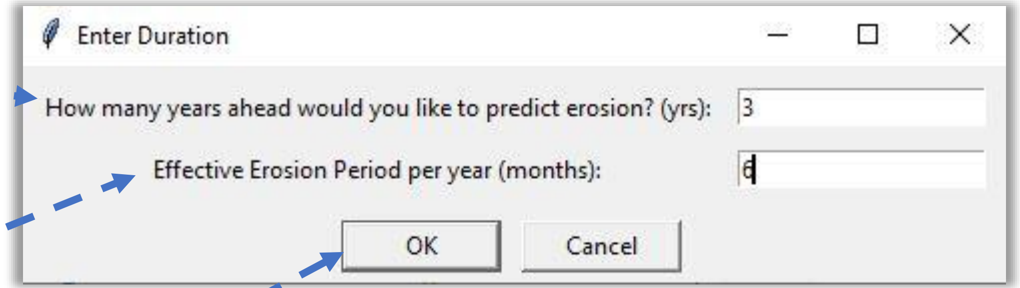
3. Specify the side of **Transect Generation** to map the direction of lateral erosion with either 0 (for Left or 1 (for Right), given that the bankline is drawn from upstream to downstream

4. Click the **Submit** button



Step 5: Setting the time period for Future Prediction

1. Specify "How many years ahead you want to predict Erosion" in years.



2. Enter the **Effective Erosion period** of a year, considering the time period of erosion calculation

3. Then, Click the "OK" button to proceed to the next step

Step 6: Data Visualization

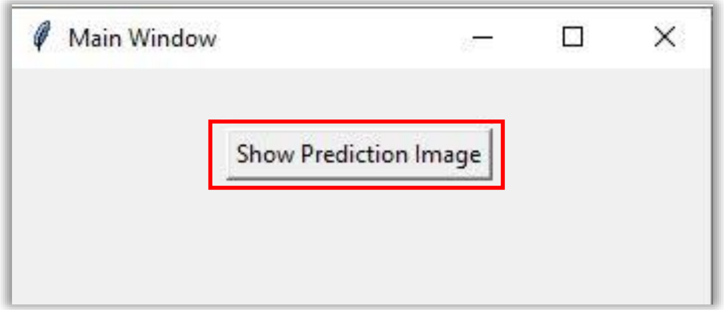
Excel Data Display

Unnamed: 0	Actual_erosion	latitude	longitude	s	Erosion(m)	geometry	ids
0	2	648506.8178312579	496731.6637811604	-600	0	POINT (496731.6637811	1
1	20	648313.2007128316	496781.4475146552	-400	1	POINT (496781.4475146	2
2	30	648117.4101288484	496820.0094789197	-200	21	POINT (496820.0094789	3
3	54	647919.0531124603	496800.8941557812	0	45	POINT (496800.8941557	4
4	56	647743.159068881	496707.4268637575	200	13	POINT (496707.4268637	5
5	9	647587.057700039	496583.2628603537	400	5	POINT (496583.2628603	6
6	0	647465.5345133494	496424.7388945642	600	0	POINT (496424.7388945	7

Figure: Data Table

1. Data table shows the Actual and Predicted erosion at the pre-defined calculation points

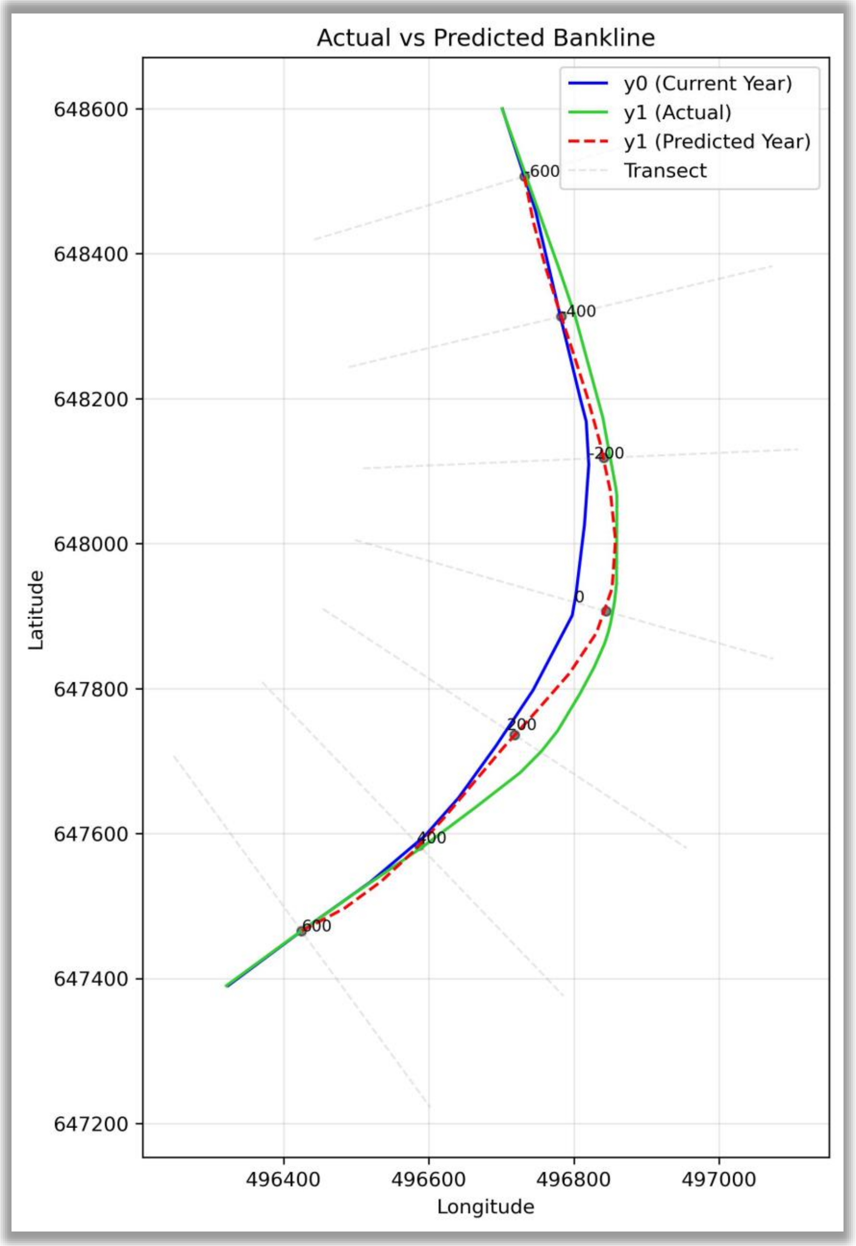
2. Click "**Show Prediction Image**" button to display the result Graph



✓ NB: Additionally, all generated files will be automatically placed in the working directory

Step 7: Prediction

Graph showing the Final Output for lateral Erosion Prediction at the desired location



Thank You