<u>User Manual</u>

Drainage Basin Analysis

- ✓ Drainage Basin Morphometry
- ✓ Geomorphic Indices
- ✓ Transient Profiler



By

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Workflow chart:



List of MATLAB functions

SI.	Scn.	OBJECTIVES	FUNCTIONS
	A1	DEM to ASCII	ArcGIS (.txt)
	A2	FAC to ASCII	ArcGIS (.txt)
	A3	Drainage divide shapefile	ArcGIS (.shp)
	B1	Stream order to .CSV file	ArcGIS(.txt)
1	B2	Channel data generation	(1) arcdemtxt2matlab_mod
2			(2) profile51_batch_mod
3			(3) auto_chn_finder
4			(4) closeto
5			(5) movavg51
6			(6) auto_ks_calc
		Basin_Morph	
7	C1	basin morphometry from order.csv and chandata.mat	(7) basin_morph
8			(8) plot_reference
9			(9) plot_drainage
10			(10) plot_divide_zoom
11			(11) plot_drainage_mouth
12			(12) inpoly
13			(13) chan_clip_ref
14			(14) basin_length_width
15			(15)asymmetry_factor
	1	Geomorphic_Indices	
16	C2	Hypsometry integral and profile	(7) hi_profiler
17			(8) plot_reference
18	C3	SL-Index with river profile	(9) sl_profiler
19	C4	Ksn and Chi profile	(10) ksn_chi_profiler
20	C5	Swath profile	(11) swath_profiler
21			(12) inpoly
	1	Transient_Profiler	
22	C6	Reference theta estimator	(7) theta_calculator
23			(8) plot_reference
24			(9) plot_dem
25			(10) plot_drainage_ref
26			(11) plot_drainage
27			(12) chan_clip_ref
28			(13) chiplot_scatter_calculator
29			(14) theta_calculator_pick
30	C7	Ksn map ploting (from profile51_batch_mod)	(15) ksnpoint2line_shp_map
31		Ksn evaluation segmentwise	(16) ksn_regress_analysis
32			(17) plot_divide
33			(18) plot_divide_zoom
34			(19) sa_analysis
35			(20) sa_regress_relict
36			(21) answer vn

37	C8	Paleo-channel reconstruction_relict theta	(22) theta_mean_relict_pick
38		Paleo-channel reconstruction_profile	(23) profile_reconstruct
39			(24) sa_regress_reconstruct
40	<u> </u>	Celerity model-Knickpoint identification	(25) knick_selector4celerity
41	69	Celerity model- minimum missfit plot	(26) celerity_model
42			(27) celerity_analysis
43		Celerity model- Fit plot at a given age	(28) celerity_model_age
44		Celerity model- GIF map	(29) celerity_model_GIF_Map
45			(30) Estimate_KnickPoint
46	C10	Spatial Chimap	(31) chimap_generator
47			(32) sa_analysis_chimap
		Some plotting functions	
48	C11	DEM plotting	plot_dem
49		reference .shp plotting	plot_reference
50		drainage plotting	plot_drainage
51		drainage with respect to reference	plot_drainage_ref

PART-A (DEM to Watershed)

A-1. Data preparation

- a) Download the required DEM data from the data distributor (we have used SRTM and ASTER data from <u>https://earthexplorer.usgs.gov/</u>)
- b) If DEM data has multiple files, mosaic the file at GIS platform
- c) The DEM should be projected into UTM projection system. (we have used UTM_Zone_46N). [note: often the projection of data involves resampling, make sure to select 'bilinear' resampling technique and mentioning the cell size is optional]
- d) For later use raw DEM grid need to be exported as ASCII files and named as <filename> followed by suffix 'dem'.

Note: A1, A2, A3 and B1 section can be perform using any GIS software (e.g. ArcGIS, QGIS). Here, we have used ArcGIS and the steps are explained in the following text.

A-2. Flow accumulation generation

Generate Flow accumulation file in any GIS platform (e.g. ArcGIS). Save DEM and Flow accumulation as ASCII files in the working directory by naming <filename> followed by suffix 'dem', 'acc' and/or '.prcpt' respectively.

(dem =>fil =>fdr =>fac)

- a) Filling Sinks (fil) This process will fill the sinks in a grid data and keep "Z limit (optional)" unchecked.
- b) Flow Direction (fdr) This process will compute flow direction using the eight direction pour point (D8) method. Keep the "force all edge cells to flow outward (optional)" unchecked.
- c) Flow Accumulation (fac) This process uses flow direction grid and generates a grid having cells that assigned by a number of connecting draining cells. Make sure that the output data type should be in **integer**.
- d) For later use Flow accumulation grid need to be exported as ASCII files and named as <filename> followed by suffix 'acc'.

Note: Make sure that the flow accumulation grid is generated from the same DEM which will be used to generate ASCII file for further processing.

A-3. Drainage divide extraction

- a) Create a pour point shapefile to determining the drainage basin outlet
- b) Snap pour point to rasterize the pour point.
- c) Generate watershed raster for drainage divide boundary
- d) Convert the extracted watershed raster to polygon shapefile and keep inside the shapefile folder.

Part-B (Drainage Network Extraction)

B-1. Drainage order extraction (only required for morphometric parameters)

- a) Use 'raster calculator' to create stream raster and classify it using 'stream order'. Then convert ordered stream raster to shapefile using 'stream to feature' tool.
- b) Merge the stream order features with respect to the order no. and then clip it by drainage divide boundary.
- c) Add stream length column in the attribute table of clipped stream order and calculate the length in meters.
- d) Export the attribute table as .CSV file

B-2. Drainage Network extraction (MATLAB)

Keep the ASCII files of DEM and Flow accumulation along with the extracted MATLAB scripts in a working directory/folder (make sure that the directory name and path should not contain any 'space', instead of 'space' use '_' while naming the directories). Make a new directory with the name of 'shapefiles' within the working directory, and keep shapefiles of drainage divide and other GIS files. The 'shapefiles' folder would contain all the input and output GIS files. Make sure the prefix of 'dem' and 'acc' ASCII files (.txt) is same (In present example 'umiam_' before 'dem' and 'acc').

The working directory would look something like this,

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	plot_divide_zoom	2/11/2019 12:45 PM	M File	2	KB	
	plot_drainage	8/28/2019 4:02 PM	M File	2	КВ	
	plot_drainage_ref	2/11/2019 12:47 PM	M File	3	KB	
	plot_reference	2/11/2019 12:48 PM	M File	2	KB	
	profile_reconstruct	4/17/2020 4:36 PM	M File	11	KB	
	profile51_batch_mod	8/28/2019 4:04 PM	M File	25	KB	
	sa_analysis	8/28/2019 4:05 PM	M File	10	KB	
	sa_analysis_chimap	8/28/2019 4:08 PM	M File	9	KB	
	sa_regress_reconstruct	2/11/2019 2:17 PM	M File	22	KB	
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The drainage network extraction is being performed using the modified code adapted from (http://geomorphtools.geology.isu.edu/index.htm).

a) Conversion of ASCII file to MAT file

arcdemtxt2matlab mod ('filename')

>>e.g.arcdemtxt2matlab_mod('umiam_')

[Note; write the initials without suffix (e.g. for file named as umiam_dem.txt and umiam_acc.txt, write as 'umiam_')]

Output: MAT files of DEM, flow accumulation and metadata.

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b) Create a text file with few predefined parameters

Create a text file named as "**run_parameters.txt**" file mentioning the input variables with space separated in following order;



(i) Cell Size: Pixel size of the raster grid

(ii) Theta Reference: generally, for bedrock river, default reference concavity is considered as 0.45. theta for more accuracy compute the theta reference for particular basin by using theta_calculator.m function (see section 4)

(iii) Remove Spikes (0/1): data spikes due to DEM artefact could be removed.

(iv)Smooth Profile (0/1): Whether to smooth elevation data or not

(v) Smoothing Window: Smoothing window in meter

(vi)Vertical Sampling Interval: Contour sampling interval (in meter) used for calculating the local slope.

(vii) Auto k_{sn} Window (km): Width of window (in meter) used in estimation of normalized steepness index

(viii) Search Distance: It is a distance for selecting the actual downstream river path from channel head.

(ix) Minimum Accumulation: Minimum area for determining the channel head.

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- c) Delineation of drainage network with channel steepness (k_{sn})
- The drainage network extraction has been performed using the modified code taken from (<u>http://geomorphtools.geology.isu.edu/index.htm)</u>.
 Run the following script,

profile51_batch_mod ('filename','n',<critical_area>)

e.g. >>profile51_batch_mod('umiam_','n',1e7) [1e7=10000000]

[Note; <critical_area> is a value in m² which is considered as the lowest accumulation area for automatically selecting the channels. Smaller the critical area, larger the number of identified channels.]

Output: creates chandata.mat files containing various estimated variables.

I-Basin Morphology

PART-C (Sets of analysis)

Table-1: List of Morphometric parameters

S.no.	Morphometric parameters	Formula	References
Α	Drainage network (Linear aspects)		
1	Stream order (Su)	$Su = Su_1 + Su_2 + \ldots + Su_n$	Strahler (1964)
2	Stream length (Lu)	$Lu = L_1 + L_2 + \ldots + L_n$	Horton (1945)
3	Stream number (Nu)	Orderwise stream count	Horton (1945)
4	Stream length ratio (RL)	RL=Lu/(Lu-1)	Horton (1945)
5	Bifurcation ratio (Rb)	$Rb=U_n/U_{n+1}$	Schumm (1956)
6	Mean stream length (Lsm)	Lsm=Lu/Nu	Strahler (1964)
7	Rho Coefficient (Rhp)	$Rh\rho = RL/Rb$	Horton (1945)
В	Basin geometry (Areal aspects)		·
8	Basin area (A) (km ²)	Calculated from Son basin boundary in GIS	Schumn (1956)
9	Basin perimeter (P) (km)	Calculated from Son basin boundary in GIS	Schumn (1956)
10	Basin length (Lb) (km)	Distance from outlet to farthest point on the basin boundary	Schumn (1956)
11	Basin width (Wb) (km)	Longest perpendicular distance to basin length across the basin	Schumn (1956)
12	Main Channel Length (Cl) (km)	Length longest water course from outlet to upstream	
13	Fitness ratio (Rf)	Rf = Cl/P	Melton (1957)
14	Form factor (Ff)	$Ff = A/Lb^2$	Horton (1945)
15	Relative perimeter (Pr)	Pr=A/P	Schumn (1956)
16	Length area relation (Lar)	Lar=1.4*A^0.6	Hack (1957)
17	Drainage density (Dd) (km/km ²)	Dd=Lu/A	Horton (1945)
18	Drainage texture (Dt)	Dt=Nu/P	Horton (1945)
19	Elongation ratio (Re)	$Re = Dd/Lb = 1.128\sqrt{A/Lb}$	Schumm (1956)
20	Circularity ratio (Rc)	$Rc = 4pi*A/P^2$	Strahler (1964)
21	Compactness coefficient (Cc)	$Cc = 0.2821 * P/A^{0.5}$	Strahler (1964)
22	Stream frequency (Fs) (No/km ²)	Fs = Nu/A	Horton (1945)
23	Constant of channel maintenance (C)	C = 1/Dd	Schumn (1956)
24	Infiltration Number (If)	If = Fs*Dd	Faniran (1968)
25	Drainage Intensity (Di)	Di = F/Dd	Faniran (1968)
26	Length of overland flow (Lg)	Lg=1/2Dd	Horton (1945)
27	Wandering ratio (Rw)	Rw = Lc/Lb	Smart and Surkan (1967)
C	Relief characteristics (Relief aspects)		
28	Total basin relief (R)	R = H-h (height of the mouth)	Strahler (1952)
29	Relief ratio (Rr)	Rr = R/Lb	Schumm (1956)
30	Relative relief ratio (Rh)	Rh = (R/P)*100	Melton (1957)
31	Gradient ratio (Rg)	(Elevation of source- Elevation of	Horton (1932)

		mouth)/Lb	
32	Ruggedness Number (Rn)	$Rn = Dd^*(R/1000)$	Patton and Baker (1976)
33	Melton Ruggedness Number (MRn)	MRn = R/A0.5	Melton (1957)
D	Others		
34	Sinuosity Index (Snt)	Snt=Actual length of trunk channel/ shortest distance from channel head to mouth	Stølum, H.H., (1996)
35	Asymmetry Factor (AF)	AF=(Area _{Right} /Area _{Total})*100	Keller and Pinter(1996)

C-1. Morphometric parameter extraction

Run the following script for extracting the above mentioned parameters;

basin_morph(FileName, OrderText, DivideShapefile)

e.g. >>basin_morph('umiam_','order_aster_v2.csv','umiam_divide')

>>to determine the river mouth/exit point, select a random channel headconfined within the drainage boundary.

(click on any channel head within the basin boundary to determine the basin outlet point which will be used as reference point for determining all the channels that falls inside the basin)



Following outputs will be displayed in the command window and a textile containing all the parameters will created in the working directory;

Command Window							\odot
53 chandata fall	ls inside the basi	n					^
55 chandata fall	ls inside the basi	n					
57 chandata fall	ls inside the basi	n					
66 chandata fall	ls inside the basi	n					
	ORDERWISW DRA	INAGE PARAMETERS-					
	Stream_number	Stream_length	Mean_stream_length	StreamLength_ratio	Bifurcation_ratio	Rho_Coefficient	
1	123	189.09	1.5374	NaN	NaN	NaN	
2	24	93.21	3.8835	0.4929	5.125	0.096176	
3	4	31.67	7.9168	0.33976	6	0.056626	
4	1	63.06	63.062	1.9914	4	0.49785	
Order/Mean	38	94.258	19.1	0.94136	5.0417	0.21688	
	-LINEAR ASPECTS OF	THE BASIN					
Stream order (u)		= 4					
Stream length st	im (Lus) (Km)	= 377.03					
Stream number su	am (Nus)	= 152					
Mean stream leng	gth (RLs)(km	= 2.4805					
Mean Difurcation	n ratio (RDM)	= 5.0417					
Mean stream leng	gth ratio (KLM)	= 0.94136					
Mean Kno Coeffic	ADEAL ASDECTS OF	= 0.21655					
CONTRACTOR	AREAL ADPECTS OF	INE DADIN					
Amon (3) (Imm (2)	XI >>	- 409 2062					
Desimator (D) (Im		- 161 9205					
Perimeter(F) (An	(1m)	= 49 9411					
Basin width (Wh)	(km)	= 16 2799					
Longest channel	length(Cl) (km)	= 79,182					
Fitness ratio (F	Rf)	= 0.48929					
Form Factor (Ff)		= 0.2006					
Shape factor rat	tio (Sf)	= 4.9852					
Relative paramet	ter (Pr) (km)	= 3.0792					
Length area rela	ation (Lar)	= 58,1602					
Drainage density	z(Dd) (km/km^2)	= 0.75662					
Drainage texture	e (Dt)	= 0.93925					
Elongation ratio	(Re)	= 0.50528					
Circularity rati	io (Rc)	= 0.2392					
Compactness coef	fficient (Cc)	= 8,1786					
Stream frequency	(Fs) (No/km^2)	= 0.30503					
Constant of char	nnel maintenance(C	:) = 1.3217					
Infiltration num	mber (If)	= 0.23079					
Drainage intensi	ity (Di)	= 0.40315					
Length of overla	and flow (Lg)	= 0.66083					
Wandering ratio	(Rw)	= 1.5887					
	RELIEF ASPECTS OF	THE BASIN					
Total basin reli	ief(R)	= 1.952					
Relief ratio (Rr	c)	= 0.039164					
Gradient ratio(F	Rg)	= 0.037618					
Ruggedness numbe	er (Rn)	= 1.4769					
Melton ruggednes	ss number (Mrn)	= 0.087444					
Relative relief	(Rh)	= 1.2062					
	OTHER PARAMETERS	OF THE BASIN					
Sinuosity (Snt)		= 1.5937					
Asymmetry factor	c (AF_m)	= 57.5916					
Asymmetry factor	r (AF_b)	= 42.4084					
\$ >>							~

And following plots will be generated in various figure window;









II-Geomorphic indices

(C-2) Hypsometric Integral

hi_profiler('filename', 'drainage divide')

e.g. >>hi_profiler ('umiam_', umiam_divide')

- Input: 'filename' and 'drainage divide' [Note; drainage divide file keeps as a .shp file in a folder]
- Output figures (1) shows the drainage basin and figure (2) shows Hypsometry integral





(C-3) SL- Index

sl_profiler('filename')

e.g. >>sl_profiler('umiam_')

- Input: 'filename' and 'channel_count'

[Note: channel_count can be seen in the command window after run the program]

- i) enter the mouth reference shapefile name or for choosing reference manually, enter <0>:
- ii) select the reference point near the mouth of the drainage by clicking on figure (1)..
- iii) select channel from the figure (1) by clicking near the river head and assign a name...



iv) enter the channel name :



- v) Enter SL interval in meter else go for the default(5000m) interval by giving " 0 ":
- vi) Enter smoothing interval OR to choose default interval(1000m) enter < 0 >:
- vii) Do you want to change y-axis limits (1/0):
 - (1) Enter the Elevation y-axis minimum limit :
 - (2) Enter the Elevation y-axis maximum limit :
 - (3) Enter the SL y-axis minimum limit :
 - (4) Enter the SL y-axis maximum limit :
- viii) Do you want select another channel (1/0):



(C-4) Normalized steepness index (k_{sn})

The steepness indices are being automatically calculated for each channel while running the 'profile51_batch_mod' code at the reference theta mentioned in the 'run_paraeters.txt' file. For visualization and plotting purposes, run the following code with the given soothing window.

ksn_chi_profiler(file_name, ChanNum,Cont_Intv,theta)

e.g. >>ksn_chi_profiler('umiam_', 79,20,0.45)

Input: drainage divide filename and

- i) enter the reference shapefile name in single inverted comma Or choose manually by entering <0>:
 - \star Figure 1 × File Edit View Insert Tools Desktop Window Help 1666 1 4 4 4 5 4 7 -106 2.83 2.825 2.82 2.815 2.81 2.805 2.8 2.795 2.79 2.785 2.78 3.5 3.6 3.7 3.8 3.9 $\times 10^5$
 - ii) select the channel by clicking near the river head and assign a name...



iii) enter the channel name in single inverted comma :





iv) do you want select another channel (1/0):

Note: The k_{sn} values which falls within the desired basin boundaries are only reliable because they are being estimated for the respective accumulation area (which covers the entire basin area).

(C-5) Swath Profile

swath_profiler('filename', 10)

e.g. >>swath_profiler('umiam_', 10)

Input: 'filename' and 'swath width' in km

- i) for swath profile from DEM, enter "1" OR for precipitation data enter "0" :1
- ii) for pre-defined swath line, enter "1" OR for manual input in figure(1), enter "0" :'swath_umiam'





i) for swath profile from DEM, enter "1" OR for precipitation data enter "0" :0



ii) for pre-defined swath line, enter "1" OR for manual input in figure(1), enter "0" : 'swath_umiam'



III-Transient profiler

(C-6) Theta reference estimator (Optional)

Keep the reference .shp file in the shapefiles folder. You can give drainage divide (boundary) as reference file.

theta_calculator('filename', 'ref_filename')

e.g. >>theta_calculator('umiam_','umiam_pour_pt')





theta_calculator_pick('dem_filename','ref_filename')

e.g. >>theta_calculator_pick('umiam_','umiam_pour_pt')

- v) enter the number of channel that are being considered :16
- vi) select channel from the figure (1) by clicking near the river head...







(C-7) Steepness index (ksn) analysis

(C-7.1) ksn map generation (regional map)

The steepness indices are being automatically calculated for each channel while running the 'profile51_batch_mod' code at the reference theta mentioned in the 'run_paraeters.txt' file. For visualization and plotting purposes, run the following code with the given soothing window;

ksnpoint2line_shp_map('dem_name','ref_name',smooth_wind)

e.g. >> ksnpoint2line_shp_map('umiam_','umiam_divide',10)

Note: The k_{sn} values which falls within the basin boundaries are only reliable because they are being estimated for the respective accumulation area (which covers the entire basin area).

For recalculating the theta k_{sn} at different reference theta, first modify the 'run_parameters.txt' and run the 'profile51_batch_mod' code again.



Output files: 'ksn_shapefile' would be created inside the 'shapefile' directory which can be used in a GIS platform.

(C-7.2) ksn regression parameters

Steepness index for the segment of channel via regression

ksn_regress_analysis('dem_name','divide_name','ref_name',Theta_ref)

e.g. >>ksn_regress_analysis('umiam_','umiam_divide','dauki_fault',0.45)





vii)select channel from the figure (1) by clicking near the river head...

- viii) From which plot would you like to pick regression limits? (or enter "d" for manual input)
 - a) logS-logA (fig2 plot3); b) long profile (fig2 plot1); c) Chi(distance) : b
- ix) Include Click on LEFT (max dfm) then RIGHT (min dfm) bounds for regression from STREAM PROFILE (fig2, plot 1)

Regress bounds must include at least 3 data points -- crosses on LOG(S)-LOG(A) PLOT...



x) do you want to keep the regress value (y) or reselect regression range (n) :
 (y/n).... y

If 'n', it will go to step (iii) and start freshly.

xi) do you want another S-A regression : (y/n).... n

If 'y', it will go to step (iii) and ask the for another regression range

- xii)Click the upper left corner to locate temporary parameter text.
- xiii) do you want to go for another channel : (y/n).... **n**

If 'y', return to figure (1) and repeat the steps from (i) to (vii) for another channel selection.

Output files: S-A regression plots, S-A regress mat files and figure with selected channel

(C-8) Paleo-channel reconstruction

The paleo-base level of any transient state river can be reconstructed based on the scaling parameters (steepness and concavity index) of relict reach which assumed as representative of previous uplift-erosion setting. The geomorphic and hydrological variation at a smaller drainage area can lead to the great variation in steepness index (k_{sn}) (Clark et al., 2005; Wobus et al., 2006; Gallen et. al., 2013). To avoid such complication, channel steepness indices (k_{sn}) were normalized using the mean concavity (θ_{ref}) of all the identified relict reaches. The function mention below can be used to analyse the channels having relict

reaches and estimate the θ_{ref} . The selected regression segment should be within the relict reach and contain significant number of data points.

(C-8.1) Mean theta estimation

theta_mean_relict_pick('dem_name', 'divide_name','ref_name',Theta_ref)

e.g. >>theta_mean_relict_pick('umiam_','umiam_divide', 'umiam_divide',0.45)

(The steps are similar with the steps involve in '5.1. ksn regression parameters')

- i) select channel from the figure (1) by clicking near the river head
- ii) From which plot would you like to pick regression limits? (or enter "d" for manual input)
- a) logS-logA (fig2 plot3); b) long profile (fig2 plot1); c) Chi(distance) : a

Click on minimum THEN maximum bounds for drainage area from LOG(S)-LOG(A) PLOT (fig2, plot 3)

Include at least 3 data points -- crosses on LOG(S)-LOG(A) PLOT

- iii) do you want to keep the regress value (y) or reselect regression range (n) : (y/n)....
- iv) do you want to go for another channel : (y/n)....

[Repeat step (i) to (v) until all the relict reaches are covered]

Output file: mat files containing SA regress parameters of relict reaches will be produced and the estimated mean theta will be shown in the command window. The mean theta will be latter used as theta_ref for the reconstruction of paleo-base level.

(C-8.2) Paleo-base level reconstruction

Once the mean theta has calculated, the paleo-base level can be reconstructed using the following matlab function,

profile_reconstruct('dem_name','divide_name','ref_name',Theta_ref)

e.g. >>profile_reconstruct('umiam_','umiam_divide', 'umiam_divide',0.3)

(The steps are similar with the steps involve in '5.1. ksn regression parameters')

i) select channel from the figure (1) by clicking near the river head



- a) logS-logA (fig2 plot3); b) long profile (fig2 plot1); c) Chi(distance); (fig3 plot2): a
- ii) Click on minimum THEN maximum bounds for drainage area from LOG(S)-LOG(A) PLOT (fig2, plot 3)
 Include at least 3 data points -- crosses on LOG(S)-LOG(A) PLOT
 Click the upper left corner to locate temporary parameter text.
- iii) do you want to perform the reconstruction (y) or go for reselect the relict segment(n): (y/n)....y



- iv) do you want another S-A regression : (y/n)....n
- v) Mark points on long profile? (y/n)....

vi) a) logS-logA (fig2 plot 3); b) long profile (fig2 plot1); c) logS-dfm (fig3 plot 2):b



- vii) Classify this point? (y/n)
- viii) Major Knick; 2) Minor Knick; 3) Start of Steep Sect.; 4) End of Steep Sect.; 5)Other? 1
- ix) Mark another point? (y/n)....n
- x) select another channel selection : (y/n).... **n**

(C-9) Knickpoint retreat model (Celerity model)

(C-9.1) Knickpoint identification

% listing the observed knickpoints

knick_selector4celerity ('dem_filename','divide_filename', 'ref_filename')

>>knick_selector4celerity ('umiam_','umiam_divide', 'dauki_fault')

ii) select Trunk channel for reference from the figure (1) by clicking near to the channel head...



iii) select channel from the figure (1) by clicking near the river head...



- iv) Mark points on long profile? (y/n)....
- v) From which plot would you like to mark points?
 - a) logS-logA (fig2 plot 3); b) long profile (fig2 plot1); c) logS-dfm (fig3 plot 2):b



vi) Classify this point? (y/n)....



vii) How do you want to classify it?

- Major Knick; 2) Minor Knick; 3) Start of Steep Sect.; 4) End of Steep Sect.; 5) Other?1
- viii) Mark another point? (y/n)....n
- ix) select another channel selection : (y/n)....nselect another channel : (y/n).... n

(C-9.2) Celerity parameters estimator (Celerity Model)

% modify the input parameters and run directly

celerity_model('dem_name_',ref_name')

e.g. >>celerity_model('umiam_','dauki_fault')



i) enter the age range for celerity run = $(0.5:0.5:10)*10^{6}$





Output files: knickpoint retreat rate plot, misfit plot and m vs K parameters plot

(C-9.3) Celerity model for an age fit

celerity_model_age('umiam_','dauki_fault')

e.g. >>celerity_model_age('umiam_','dauki_fault')

i) enter the age to the examine the observed vs modeled knickpoits = $4*10^{6}$



(C-9.4) GIF animation for Celerity Model for given age

celerity_model_GIF_Map('dem_name','divide_name', 'ref_name')

e.g. >>celerity_model_GIF_Map('umiam_','umiam_divide', 'dauki_fault')



i) enter the age to the examine the observed vs modeledknickpoits $=1.5*10^{6}$

(C-10) Spatial chimap generation

chimap_generator('dem_name', 'divide_name', 'ref_name')

e.g. >>chimap_generator('umiam_', 'umiam_divide', 'contour_20')

x) Enter contour value OR enter "0" for confluence reference :20





e.g. >>chimap_generator('umiam_', 'umiam_divide', 'umiam_pour_pt')

(C-11) Miscellaneous functions

% data visualization

plot_dem('dem_name')

e.g. >>plot_dem('umiam_')



plot_divide('divide_name')

e.g. >>plot_divide('umiam_divide')



plot_divide_zoom('divide_name')

e.g. >>plot_divide_zoom('umiam_divide')



plot_reference('ref_name')

e.g. >>plot_reference('contour_20')



plot_drainage()

e.g. >>plot_drainage()





plot_drainage_ref('ref_name')

e.g. >>plot_drainage_ref('umiam_pour_pt')



Point data to shapefile converter

For chimap:

chipoint2line_shp('chimap_pointdata.txt',smooth_wind)

```
e.g. >>chipoint2line_shp('chimap_pointdata.txt',10)
```

For steepness map:

ksnpoint2line_shp('ks_pointdata.txt',smooth_wind)

e.g. >>ksnpoint2line_shp('umiam_ks_data.txt',10)