Flashfoods at Bamako: mecanism and processes

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Background

The city of Bamako, capital of the Republic of Mali is characterized by recurrent floods. The last to date happened on the 16th of May 2019 that resulted in 28 casualties, enormous academic losses and environmental pollution. A question often come into mind: what make the site of the city susceptible to floods? It is possible to predict the floods?

Bamako is located along the Niger River that crosses the city E-W but the city has rarely been flooded by the Niger River. Very often the city has been flooded by the rivers running down the hills surrounding the city. Any of these rivers is gauged. How is it possible to predict the hydrological behavior of such rivers? One has to rely on empirical models



SPARK 3

Conceptual approach

Different attempt has been made to try to understanding the hydrology of the rivers but the research area has been focused on the administrative boundary of the city. Our approach is based on the definition of process at the drainage basin level. It takes into account all the contributing area around the city.

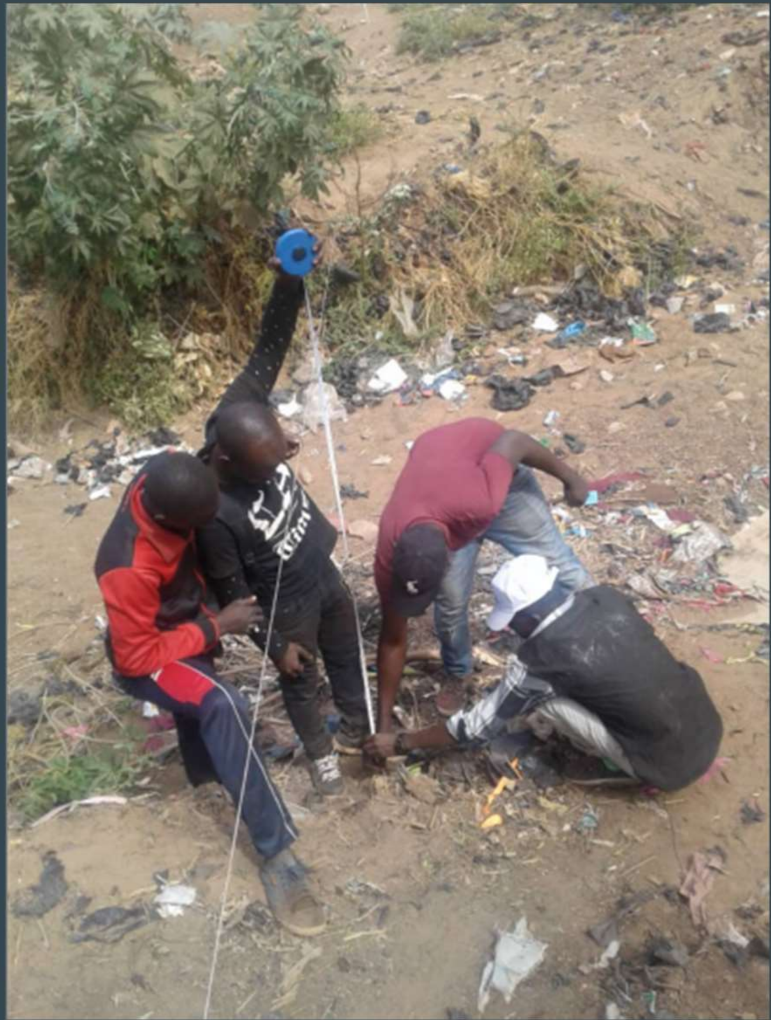
It is geomorphologically based, taking into account the morphometry characteristics of the rivers at different scales: drainage basin, tributaries and channel as well as a well definition of the geomorphological units of the city.

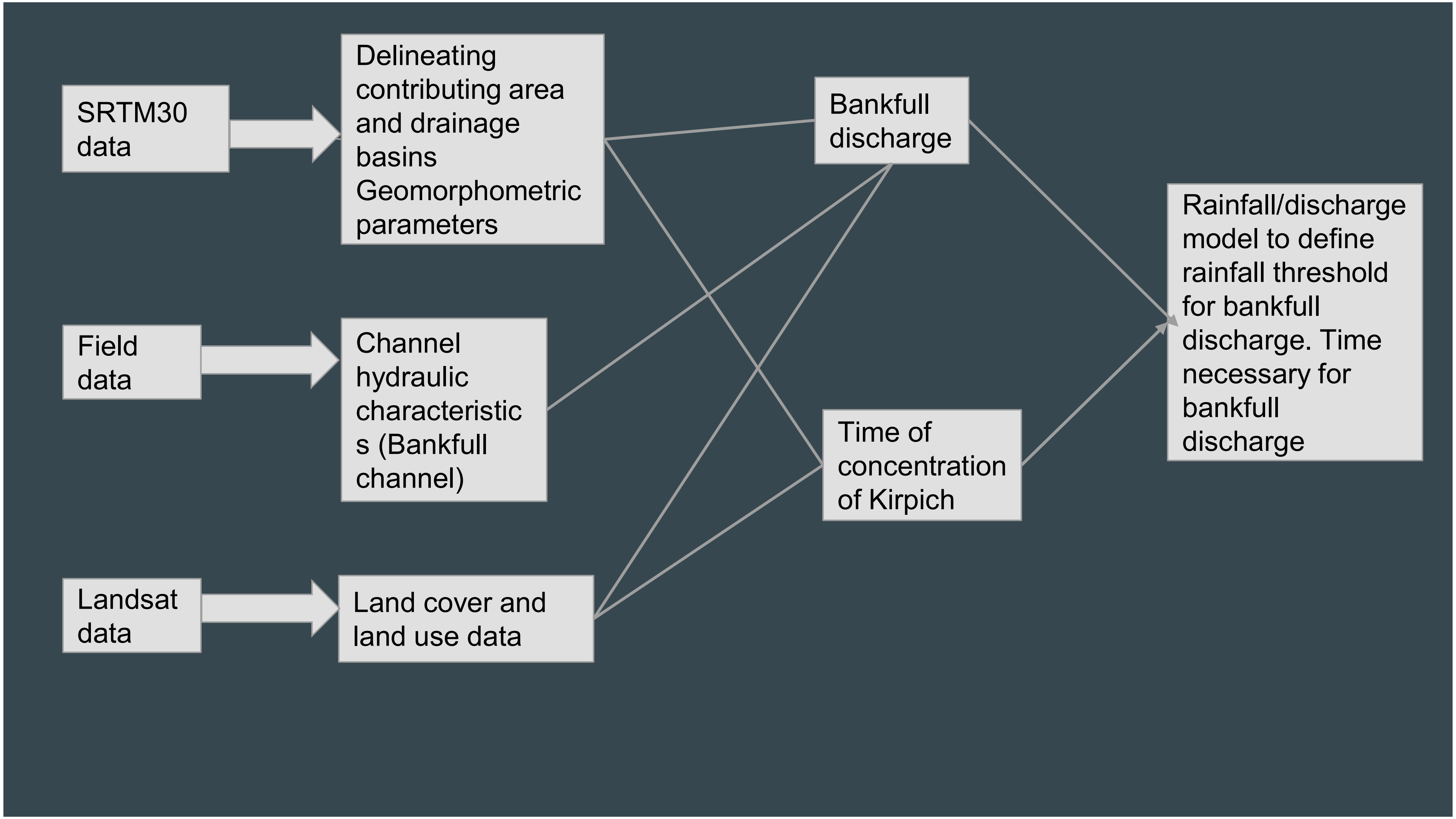
Methodology

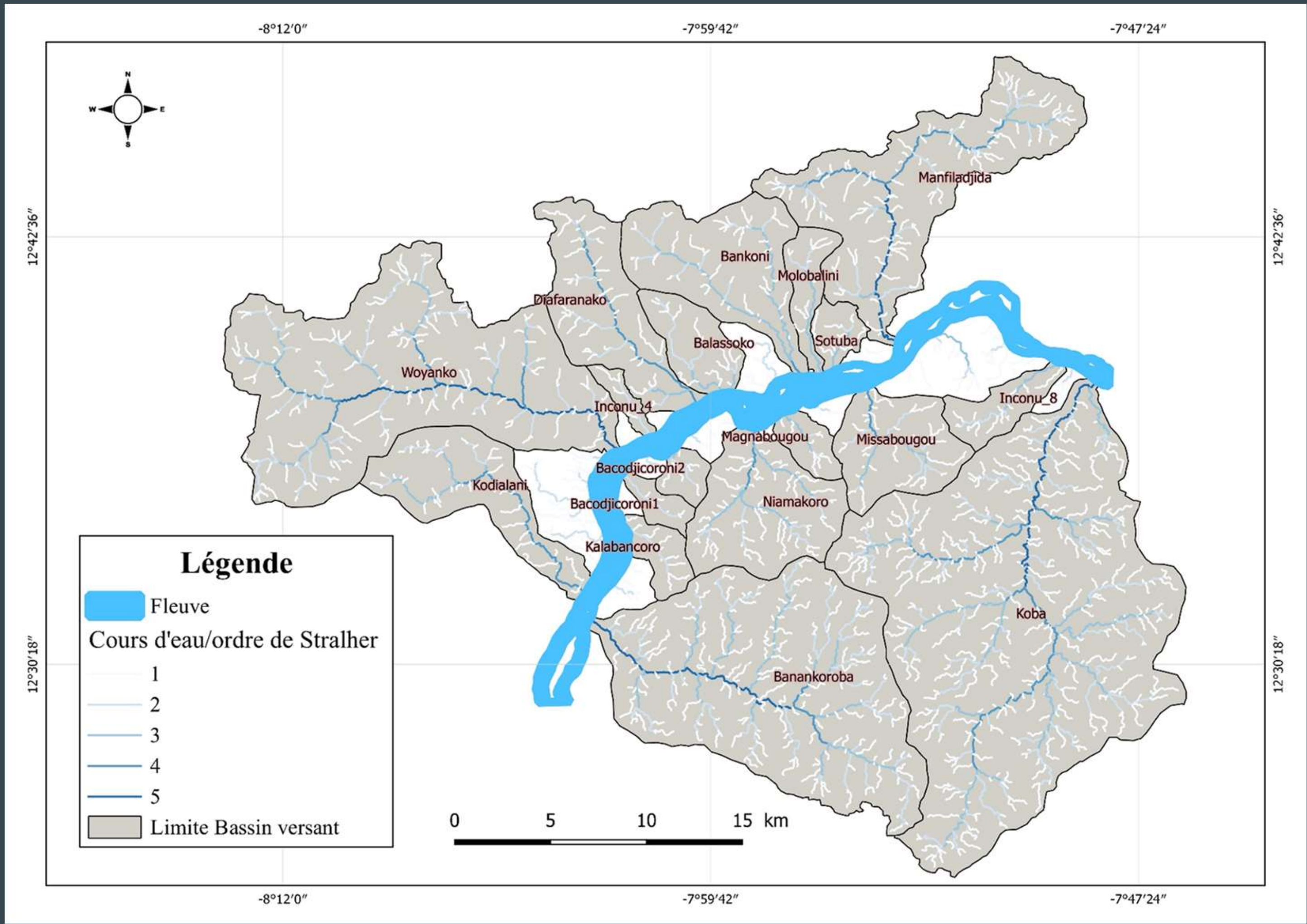
- Geomorphometric analysis through remote sensing data (Radar and satellite images)
- Participatory cartography of the effectively flooded area with the communities
- Fieldwork to record data about the river channels

Sources of data

- SRTM 30m resolution used to extract river network corrected using landsat images. The river network was organized into 19 drainage basins whose geomophometric parameters pertaining to hydrological behavior were extracted. Landsat images were used to process land cover.
- the cartography with the communities helped to define the spatial cover of former floods as well as the depth of floods on site which GPS location were recorded. Those depth were used on the SRTM 30m to carve flooded area.
- Measurement on the field of channel hydraulics characteristics pertaining to floods especially the bankfull discharge. Floods occur when bankfull discharge as a threshold is obtained.

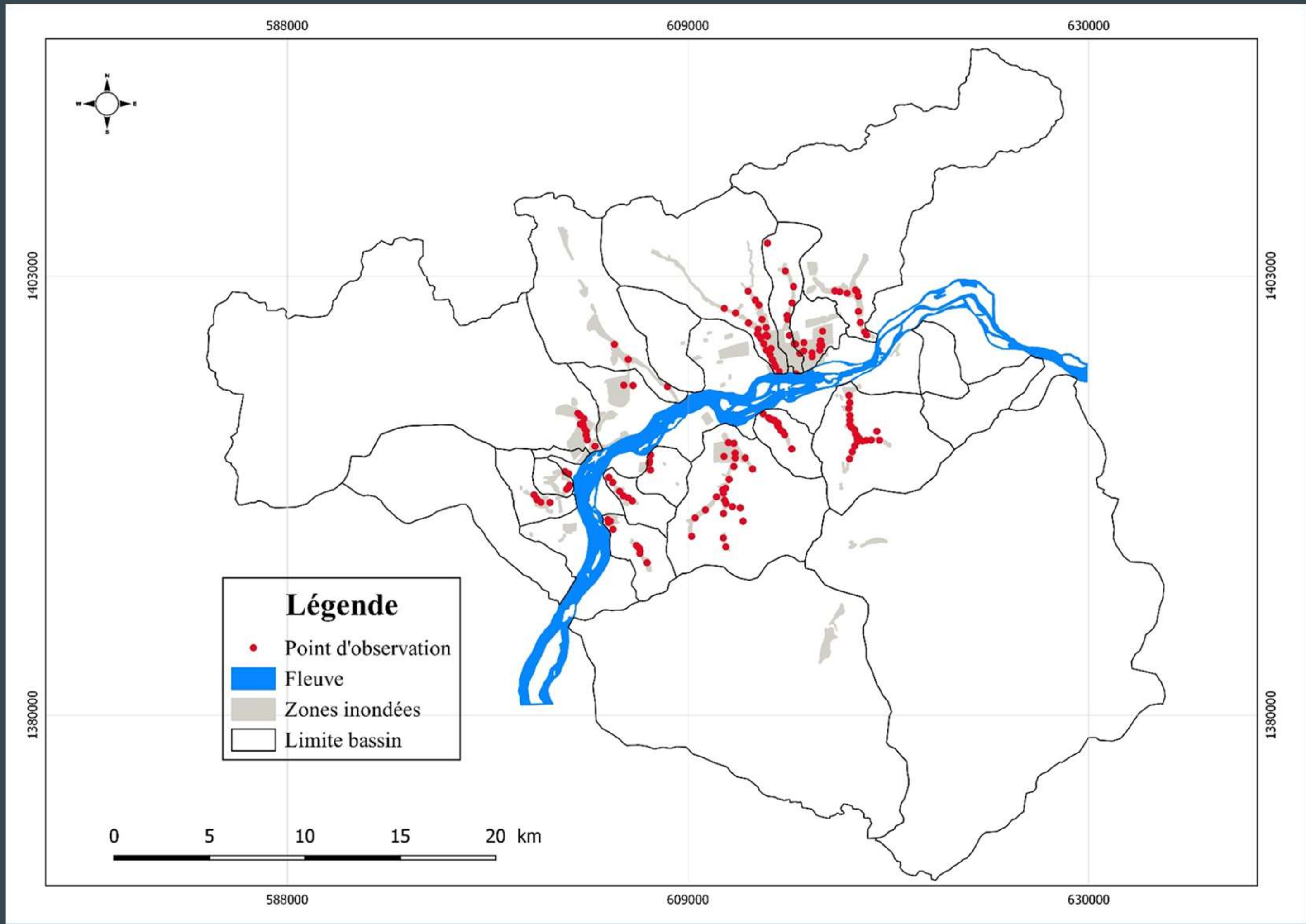

SRTM30 data
Delineating contributing area and drainage basins Geomorphometric parameters
Bankfull discharge
Field data
Channel hydraulic characteristics (Bankfull channel)
Rainfall/discharge model to define rainfall threshold for bankfull discharge. Time necessary for bankfull discharge
Time of concentration of Kirpich
Landsat data
Land cover and land use data



-8°12′0″
-7°59′42″
-7°47′24″
12°42′36″
12°30′18″
N
S
W
E
Manfiladjida
Bankoni
Molobalini
Diafaranako
Balassoko
Sotuba
Woyanko
Inconu_4
Inconu_8
Magnabougou
Missabougou
Bacodjicoroni2
Bacodjicoroni1
Kodialani
Niamakoro
Kalabancoro
Koba
Banankoroba
Légende
Fleuve
Cours d'eau/ordre de Stralher
1
2
3
4
5
Limite Bassin versant
0 5 10 15 km

Nom	Superficie	Perimètre	Longueur cours d'eau principale	Rapport d'allongement (Ra)	Rapport de circularité (Rc)	Facteur de forme (Ff)
Bacodjicoroni1	6,02	12,30	4,58	0,61	0,50	0,29
Bacodjicoroni2	5,99	9,82	3,61	0,77	0,78	0,46
Balassoko	13,89	17,29	8,16	0,52	0,58	0,21
Banankoroba	157,49	57,75	27,96	0,51	0,59	0,20
Bankoni	50,80	35,19	14,58	0,55	0,52	0,24
Diafaranako	40,38	35,37	16,02	0,45	0,41	0,16
Inconu_4	4,65	12,44	5,54	0,44	0,38	0,15
Inconu_6	4,17	9,92	3,62	0,64	0,53	0,32
Inconu_8	13,09	18,52	4,86	0,84	0,48	0,55
Kalabancoro	9,59	14,50	5,23	0,67	0,57	0,35
Koba	272,85	81,38	38,98	0,48	0,52	0,18
Kodialani	41,75	35,87	18,97	0,38	0,41	0,12
Magnabougou	7,99	11,90	25,18	0,13	0,71	0,01
Manfiladjida	90,99	61,77	4,70	2,29	0,30	4,11
Missabougou	32,27	23,90	8,98	0,71	0,71	0,40
Molobalini	11,63	20,30	9,23	0,42	0,35	0,14
Niamakoro	45,84	29,05	11,03	0,69	0,68	0,38
Sotuba	7,64	12,80	4,02	0,78	0,59	0,47
Woyanko	158,57	70,15	28,89	0,49	0,40	0,19

Nom	Densité de drainage (Dd)	Fréquence du flux (Fu)	Rapport de bifurcation (RB)	Rapport de Longueur (RL)	Texture du drainage (Td)	Longueur l'écoulement de surface (Lo)
Bacodjicoroni1	1,28	1,16	4,00	8,82	1,49	0,64
Bacodjicoroni2	1,56	2,27	2,83	1,03	3,54	0,78
Balassoko	1,33	1,19	3,32	2,56	1,59	0,67
Banankoroba	1,49	1,69	3,88	2,05	2,52	0,74
Bankoni	1,15	1,18	3,60	1,30	1,35	0,57
Diafaranako	1,19	1,38	6,56	4,78	1,63	0,59
Inconu_4_Cite	1,97	1,52	4,00	3,25	2,99	0,99
Inconu_6	1,72	2,40	2,24	1,41	4,13	0,86
Inconu_8	1,26	0,95	5,00	4,24	1,20	0,63
Kalabancoro	1,20	2,09	3,74	3,22	2,51	0,60
Koba	1,55	1,79	4,39	2,30	2,77	0,78
Kodialani	1,08	1,26	3,29	2,44	1,37	0,54
Magnabougou	1,13	1,39	8,00	7,09	1,56	0,56
Manfiladjida	1,24	1,52	4,69	3,28	1,88	0,62
Missabougou	1,32	1,33	5,83	3,50	1,76	0,66
Molobalini	1,29	1,54	14,00	10,21	1,98	0,65
Niamakoro	1,42	1,86	3,83	2,17	2,63	0,71
Sotuba	1,63	1,51	8,00	4,58	2,45	0,81
Woyanko	1,11	1,32	3,66	2,32	1,46	0,55


588000
609000
630000
1403000
1380000
Légende
Point d'observation
Fleuve
Zones inondées
Limite bassin
0
5
10
15
20 km

Processing of hydrologic behavior

02 main behavior were in sight: the time of response or time of concentration of the different drainage basins and the discharge especially the one which crosses the bankfull discharge.

- Time of response or time of concentration: Kirpich method.

  $Tc = 0.0195k\ (L^{0.77}/S^{0.385})$.

- This model is used because of the input variables can be processed from SRTM30 and landsat data. L is the length of the main river, S is the slope gradient, k is the kirpich adjustment factor related to the type of land cover.

- the bankfull discharge

  $Q=VA= (1/n (A*R^{2/3}*S^{1/2})$

R is the hydraulic Radius measured in the field, A, the flow area measured in the field, S the slope gradient processes from SRTM 30m, and n defined from landsat image or in the field.

- Apply a rainfall/discharge model to define the intensity of rainfall that can trigger this bankfull discharge. We are testing some methods used in Morocco is quite resembling climate.

Limitations of the method

- Low resolution of DEM efficient in hilly regions but not that good in flat areas. Better resolution means better definition of parameters
- high resolution can help make good maps of the geomorphological units
- Difficulties to provide accurate rainfall data because rain is very unequally distributed spatially.