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Comparative analysis between KINEROS2 and SWAT for hydrological modeling: A case study from Tleta Watershed in Morocco

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***Abstract**—Hydrological models are very useful tools for simulating the effect of natural processes and management practices on soil and water resources at the watershed level. However, the applicability of a model relies on the accuracy to simulate measured data. Thus, the aim of this study is a comparative review of the results of two recent studies carried out on the tleta watershed, to evaluate the performance of two models, namely KINEROS2 (Kinematic Runoff and erosion), coupled with AGWA (Automated Geospatial Watershed Assessment), and SWAT (Soil and Water Assessment Tool), to predict runoff and sediment yields deposited at Ibn Batouta dam at the outlet of tleta watershed. The comparative analysis between simulated and observed value of runoff and sediment yield was performed using two statistical criteria. The results showed that these two models were able to simulate runoff during the calibration period, with (R^2=0.98 and NSE=0.96) for runoff K2, and (R^2=0.92 and NSE=0.89) for SWAT. A slight reduction in agreement between sediment yields was observed for SWAT (R^2=0.84 and NSE=0.74) and a better accuracy was noted for K2 (R^2=0.99 and NSE=0.97).*

***Keywords**— Water Erosion, Hydrological Modeling, KINEROS2, SWAT, runoff, sediment yield, Tleta Watershed, Morocco.*

I. INTRODUCTION

The primary concern of water resource management is the appropriate study and planning, that's why hydrological models are used to understand the functioning of watersheds [2]. Indeed, hydrological models address water flows as well as the flow of solids, solutes, and pollutants. Furthermore, several environmental problems require model coupling to water and energy or biomass flows [3]. The comparison of the performance of different models according to the processes they describe, require different types of data and parameters [4]. Also, problems often arise during the validation processes of simulation options, spatial discretization, and in the course of expressing hydrological phenomena. Models are categorized as Global models (ORCHIDEE [5], GR2M [6]), Semi-distributed models (SWAT [7], TOPMODEL [8], WASA [9]), and Distributed models (STREAM [10], KINEROS2 [11], ANSWERS [12].

The hydrological modelling approach is based on the degree of model complexity for the representation of the real hydrological system [13]. The use of several model parameters increases the forecast uncertainty, and requires a complicated calibration procedure to reduce the risk. Robust and uncalibrated models, on the other hand, produce excellent results and are applied to uncalibrated areas [14]. However, they lack the capability to represent in detail all hydrological processes and their complete spatial and temporal distribution. By comparing a complex and a simple model with and without calibration, [15] concluded that, in a semi-arid area, a complex model requires as much as simple model a longer calibration procedure to generate results. GIS and remote sensing are tools that highlight environmental degradation due to soil water erosion by integrating physical variables and human activities [16, 17].

In this paper, we will compare the performance of two hydrological models in the Tleta watershed. Firstly, KINEROS2 [11], which is a physics-based model, whose equations describe the physical phenomenon (mass conservation, energy, etc.). KINEROS2 addresses surface erosion and the process of runoff and erosion in arid and semi-arid zones. This model was used for modeling water and solid flow in numerous pieces of researches [18-21]. It was also extensively used in Mexico (San Pedro) and Arizona, where it has been developed and validated [22-24]. KINEROS2 was likewise applied in the Mediterranean region [25], coupled with AGWA in Northern Moroccan[26], and in Africa sub-Sahara in Mali [27]. Secondly, SWAT, operating on a daily time-step basis [28], has proven its effectiveness over the years in several studies [29-31]. Its applicability in the Northern Moroccan context was tested by [32]. The model delineates the watershed using DEM and hydrographic networks. SWAT involves an extensive database (multi-source, multi-disciplinary and spatio-temporal). It is highly parameterized, which makes the calibration phase very complicated and time-consuming. The simulation results of the model will be derived from a study conducted by [32].

The main objective of this paper is to assess the performance of KINEROS2 and SWAT models under Moroccan conditions and compare the results of two modeling studies (Choukri et al.,2019; El Harche et al., 2020) carried out in the Tleta watershed in northern Morocco. Although these two hydrological models have demonstrated good performance in the assessment and the management of water resources, one needs to examine which of the models can be adapted in the Moroccan context.

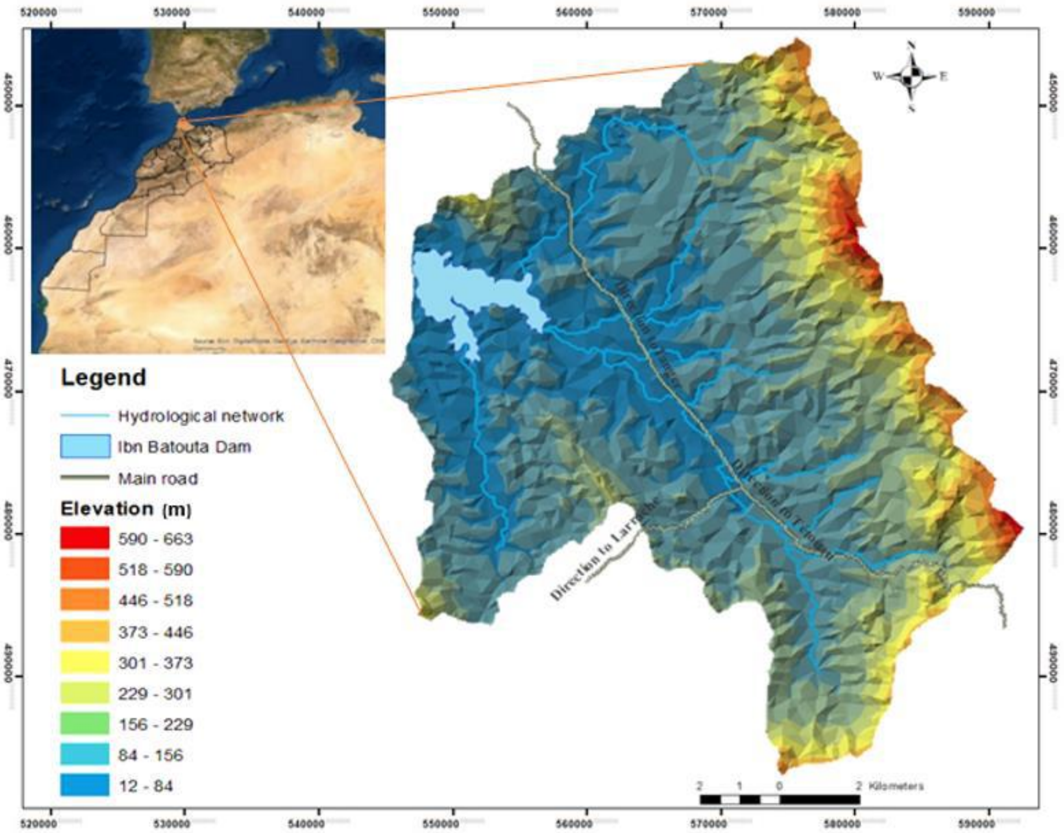

Fig.1: Geographic location and elevation of Tleta watershed

II. MATERIAL AND METHODS

1. Study site

The Tleta watershed, covering an area of 17 700 ha, is located in the Western Rif, Morocco (Figure 1). Nearby both the Atlantic Ocean and the Mediterranean Sea, the site is subjected to a dual moderate influence. Furthermore, the climate of the Tleta watershed is sub-humid with contrasted seasons, which are dry from May to September and humid from October to March [33]. The coldest month is January, with a mean temperature that reaches 8 °C. While August is the hottest month with mean temperature attaining 35 °C [34]. The Ibn Batouta dam, built with an initial storage capacity of 45 Mm³ in 1977, is now reduced to 30 Mm^3 due to annual siltation, which represents 1% of the volume of the dam [34]. Soil redistribution process is mainly controlled by topography; thus, an appropriate geometric representation of the topography is necessary to represent this process. Terrain altitude in Tleta watershed varies between 12 and 663 m.

KINEROS2 (K2) needs four sets of input data to operate, which are the digital elevation model (DEM), soils, land cover and precipitations. SWAT model similarly need these input data to describe the catchment area in terms of hydrological and geometric parameters and precipitation.

The data are summarised in Table 1, which also contains the description of erosion and runoff data used for comparison with the results obtained from the two models.

Table 1. Input dataset used to run modeling and simulations

Type	Source	Description
DEM	Spot	Digital elevation model resolution 20 m
Soils	Inypsa (1987)	Soil classes/ Soil characteristics at 1/50000
Land cover	Classified Landsat image	Land cover classes (2009, 30 m)
Rainfall	ABHL (Loukkos Hydraulic Basin Agency)	Daily rainfall, Ibn Batouta station and Saboun station at 5 min (1980-2010)
Erosion		Daily sediment yield, Ibn Batouta station (1980-2010)
Runoff		Daily runoff, Ibn Batouta station (1980-2010)

The land cover classification was processed using Landsat image (30 m). Eight classes of land cover units (Figure 2) were distinguished: Forestland (A), Woodland (B), Grassland (C), Agricultural land (D), Matorral (E), outcrop (F), Urban area (G), Water Body represented by the Ibn Batouta dam (H) [34].

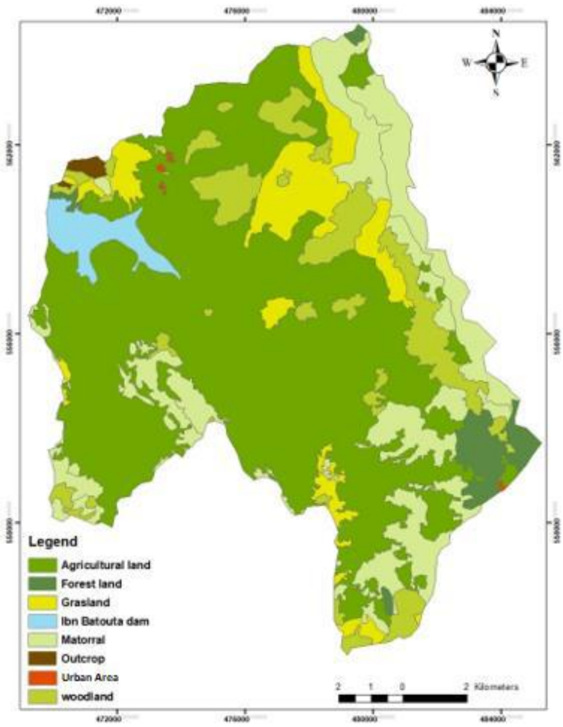

Fig.2: Map of land cover and use

Soil texture was derived from the study by [35] at a scale of 1:50000 (Figure 3). Overall, the soils of Tleta watershed belong to two soil type categories: Clay soils, which dominate the entire study area, and sandy loam clay soils that are located northwest, towards the watershed outlet.

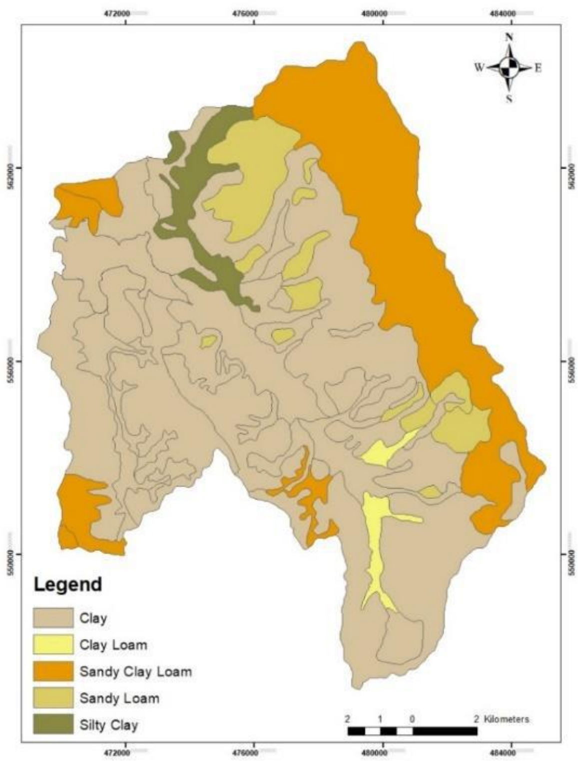

Fig.3: Map of soil texture

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The rainfall database consists of a long series (1974-2018) of data recorded at existing stations within the Loukkos river basin (Table 2). The precipitation parameters considered are total precipitation (mm), maximum intensity (mm/h) and duration of rainfall (hours). Annual rainfall in the Tleta watershed is about 709 mm/year (of which 86% falls between October and March). The climate type is Mediterranean sub-humid, with an average temperature of 18 °C.

Table 2. Meteorological data used

Name	Latitude N	Longitude W	Measures
Béni Harchane	35,531	-5,720	Daily
Ibn Battouta	35,645	-5,733	Daily
Kalaya	35,673	-5,747	Daily
Romane	35,704	-5,656	Daily
Aéroport-Tanger	35,726	-5,906	Daily

2. Models overview

The Kinematic Runoff and Erosion Model (KINEROS2) is a physical model that describes the processes of surface runoff, interception, dynamic infiltration and erosion in watersheds, mainly characterized by land-based flow as a function of topography, precipitation, soil and land cover properties [36]. Developed by Environmental Protection Agency (EPA), the Agricultural Research Service of the United States Department of Agriculture (USDA) and the University of Arizona, the tool is designed to provide qualitative estimates of runoff and erosion in relation to landscape changes. It has been developed above all to ensure that configuration procedures are simple, direct, transparent, and repeatable; which is compatible with the available GIS data layers and useful for the evaluation and development of future scenarios [37]. In this model, the watershed is represented by subdividing the area into a cascade of one-dimensional surface flows and channel elements using topographic information, in order to allow for a good understanding of watershed response to land-use changes and land cover management. The model is highly dependent on spatially distributed data; thus, the allocation of appropriate parameters takes time and complicates the compilation processes. KINEROS2, that is an updated version of KINEROS [38] has been described in details by [11]. The computation of Hortonian runoff on plans and channels is based on physical and mathematical equations as follows [11]:

$$q(x,t) = \frac{\partial h}{\partial t} + \frac{\partial Q}{\partial x}$$

$$q_c(x,t) = \frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x}$$

Where, h is the water height per width unit, Q the flow unit, A the wet section, t is the time, x the distance and q(x, t) the net inflow.

The equation of infiltrability (fc) is calculated as a function of the hydraulic saturation conductivity (Ks), the capillary drive element (G), the porosity (φ), the pore size distribution index (λ), and the accumulated infiltrated water (i).

$$f_{c=} Ks\left[1 + \frac{\propto}{e^{(\alpha 1/\beta)} - 1}\right]$$

Where α is a soil-dependent parameter, taken as 0.85 and β combining the effects of effective capillary (G), surface water height (hw) and unit storage capacity (Δθ) = (θs-θi), as in following equation.

$$\beta = (G + hw) \times (\Delta\theta)$$

The dynamic mass balance equation for erosion is giving by the following formula:

$$\frac{\partial(AC_s)}{\partial t} + \frac{\partial(QC_s)}{\partial x} - e(x,t) = q_c(x,t)$$

Where A is the cross-sectional area of flow, Cs is the local sediment concentration, Q is the water discharge, e is the surface erosion or deposition rate and q_c is the rate of lateral sediment in flow for channels.

Soil and Water Assessment Tool (SWAT), developed by the USDA agricultural research service is a conceptual agrohydrological, semi-empirical, physically based model and distributed at a daily time step [7, 39]. SWAT model is adapted to arid environments, which allow for the consideration of infiltration into river bed, as well as low flows and dynamic vegetation growth [40]. Coupled with GIS, it makes it possible to manage raster and vector data, which facilitate and automate the preparation of input data. Output files are converted to ASCII format with their structure. The model calculates for each cell, the flows and direction of water accumulation according to topography portrayed by digital elevation model. The computation grid is the Hydrologic Response Unit (HRU), which is a spatial combination of soil type, land cover and slope class in each sub-basin. The volume of surface runoff is predicted using the soil conservation service (SCS) curve number (CN). Erosion and sediment yield are estimated for each HRU using MUSLE model [41].

$$Q_{surf} = \frac{(R_{day} - I_a)^2}{(R_{day} - I_a + S)}$$

$$S = 25.4\left(\frac{1000}{CN} - 1\right)$$

Where Qsurf is the accumulated runoff, R is the daily rainfall (mm), I is the surface storage, interception and infiltration prior to runoff (mm), and S is the retention parameter.

$$Sed = 11.8 * (V_t * Q_{max})^{0,56} * K * LS * C * P$$

Where Sed is the sediment flow per day (t), Vt is the surface runoff volume (m^3), Q_{max} is the peak flow rate (m^3/s), K is the soil erodibility factor, LS is the topographic factor, C is the land cover and management factor and P is the erosion control practices factor.

In table 3 we summarized the characteristics of the two models and highlighted their advantages and limitations.

Table 3. Comparison between KINEROS2 and SWAT models

Model	KINEROS2	SWAT
Suitability	- Agricultural and urbanized basins - Small Watershed	- Agricultural basins - Cultivation practices
Surface runoff	- Hortonian flow - Kinematics equation	- SCS equation
Lateral flows	- None	- Percolation, water balance
Simulation of chemical components	- None	- N, P, pesticides, carbon
Type	- Physics	- Empirical
Spatial scale	- Distributed	- Semi-distributed
Time scale	- Event	- Continuous
Representation of the watershed	- Plans and streams, 1D	- Sub-basins, HRUs, groundwater, waterway
Operations	- Describe the processes of interception, infiltration, runoff, erosion - Used to determine the impact of developments in the watershed	- Predict the effects of land management on water - Predict the effects of sediment and chemical resources on agricultural yields in large river basins
Input	- Topography (DEM) - Soil type - Land cover - Precipitation data	- Topography (DEM) - Soil type - Land cover - Meteorological data (temperature, humidity, wind and precipitation)
Output	- Runoff m^3 - Sediment yield kg/ha - Infiltration m^3/ha - Peak flow rate m^3/s - Maximum sediment flow rate kg/s	- Precipitation (mm) - Evapotranspiration (mm) - Percolation (mm) - Surface runoff (mm) - Transmission losses (mm) - Water yield (mm) - Sediment yields (t/ha)
Advantages	- Addresses linear erosion coupled to GWA - Reduced time of use - Simple, straightforward parameter setting routine - Estimates runoff and erosion/landscape change - Useful for running scenarios	- Simulates nutrient, sediment and pesticide transfers to the drainage system and to aquifers

Limits	- Model parameters based on look-up tables (FAO database) - Needs local calibration for accuracy	- Requires large database (spatio-temporal, multi-source and multi-disciplinary) - The model is highly parameterized; thus, the calibration phase is very complex and time-consuming

KINEROS2 (Figure 4): The first step is the delineation of watershed limits. Once the boundaries are defined, the watershed is subdivided into model elements. Streams are used to define surface flow paths, and thus to control the complexity of landscape representation. The partition of the watershed into plans and channels preserves the spatial variability of the catchment's components.

This partition taking into account the relief, the hydrographic network and the spatial data series available at the global level to derive the necessary parameters for model elements [24]. The description of channel geometry is crucial for efficient water flow. The surface elements are represented by rectangular flat surfaces. The transition from the real-world watershed to the mapping scale

complies with all the geometric characteristics of the terrain (relief, micro-topography and slope). One of the particularities of K2 is that it can represent two distinct soil layers per plan. The channels are represented by two trapezoidal sections representing the main section and the minor river bed with their parameters. K2 will be coupled in this study with AGWA (Automated Geospatial Watershed Assessment), a GIS interface designed to facilitate watershed water management and analysis. AGWA tool also allows for spatial visualization and comparison of model results, and thus makes it possible to assess hydrological impacts associated with landscape changes. The use of GIS provides means of linking model results with other spatial information [37].

SWAT (Figure 4): As described previously, the first step before running the model is the delineation of the watershed from the extraction of the hydrographic network and the second step is discretization. During this phase, SWAT model delineates homogeneous hydrologic response units (HRUs) on the basis of the structure of the hydrographic network from which the sub-basins are extracted. The integration of watershed delineation and discretization is achieved by overlying the three-shape file of information, namely soil type, land cover and slope data. Once imported, the distribution of HRUs in the watershed is carried out. The SWAT-HRUs command allows us to specify the criteria for distribution. A single or multiple HRUs can be selected for each sub-basin based on soil type, land cover and dominant slope class. The construction of these units triggers the creation of SWAT view interface. This is the basis for entering the last necessary data that are climate data and agricultural practices. SWAT model is based primarily on MUSLE method, a modified version of USLE [42] [41], which calculates erosion caused by rainfall and runoff [43] and predicts average erosion as a function of rain energy. Finally, water and sediment transfer, as well as surface runoff, are predicted based on the study of [44-46]. The period selected for model initiation is 1983-2010 according to the available data.

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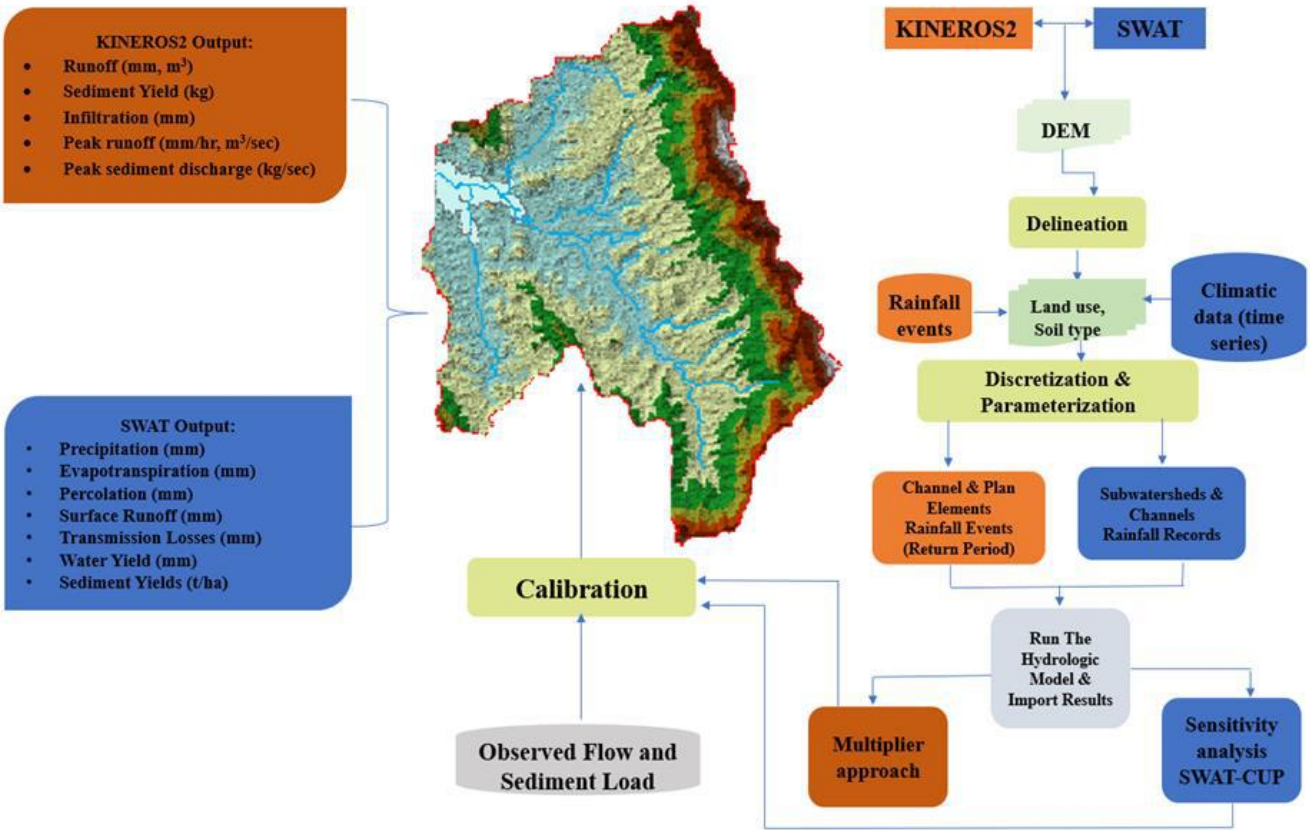


Fig.4: Operating diagram of KINEROS2 and SWAT models [1]

For **KINEROS2**, the calibration phase requires the availability of observed data. It is essential in this case to adapt some parameters, such soils, which influence strongly the simulations. The events selected for KINEROS2 calibration and validation depend on the data available. Rainfall events were used with a magnitude of small event (15 mm), medium event (21 mm), two medium large event (27 mm, 29 mm) and large event (37 mm) to evaluate the effect of rain quantity on the hydrological response of the watershed (Table 4).

The execution of the model is performed on basis of pervious field measurements in the Tleta watershed (Table 4). To calibrate K2, it is recommended to use multipliers [13, 37]. Hydraulic conductivity at saturation (MK), net effective capillarity (MG) and Manning coefficient (Mn) are the most sensitive parameters of the model [47, 48]. In our case, we will rely on Ks field measurements. The remaining parameters will be estimated using table references of the K2 original manual and documentation [38]. Model input parameters are derived directly from these data using optimized search tables provided with the tool to facilitate parameterization and calibration of K2 [37]. Data required by AGWA include elevation, land cover and soil type, in addition to rainfall data [48].

Table 4. Selected events for K2 simulations

	Rainfall	V (m^3)	I (mm/h)	Rainfall (mm)	Qs (Kg/s)
Calibration	24/12/2009	30 249	33	24	527
	03/02/1998	840 672	29	29	7 982
	28/03/2004	113 184	29	21	281
Validation	22/04/2003	254 880	27	27	1 544
	30/11/2012	375 839	33	28	3 101
	06/01/2010	2 533 247	36	37	29 519
	19/11/1999	3 455	15	15	9.91

For **SWAT** model calibration and validation, the period has been respectively decided to span over 1983-1996 and 1997-2010, to take into account initial environmental conditions [32]. All the required data are extracted from the database of [34]. Other weather data were acquired from Tangier airport and the Loukkos Hydraulic Basin Agency (ABHL) authorities. Parameter sensitivity analysis was based on changes between output variables and model parameters [49]. The sensitivity analysis was performed using SWAT_CUP program [50]. This tool identifies sensitive parameters that are related to runoff and infiltration (CN2), the interaction between river flow and underground compartment (RCHRG_DP, GWQMN, REVAPMN, GW_DELAY) and the evapotranspiration calculation factor (ESCO). The indicators elected to examine the performance of the model are the coefficient of determination (R^2), the Nash-Sutcliffe coefficient (NSE) and the bias (%PBIAS). The most sensitive parameters for sediment transport are slope (SLOPE), slope length (SLSUBBSN), Manning roughness coefficient (OV_N) and river sediment transport adjustment factor (PRF). A calibration simulation was run to adjust flows, sediments and nutrients according to the known approach [51]. Bathymetric measurements have been used to determine the sediment fluxes used during the calibration of SWAT model [32].

3. Comparison analysis

To evaluate the performance of hydrological forecasts, several criteria are involved, namely two statistical criteria (NSE) and (R^2) for both models and (%Pbias) for SWAT model only [32].

$$NSE=1-\frac{\sum i(Q_{m,i}-Q_s)i^2}{\sum i(Q_{m,i}-Q_m)i^2}$$

$$R^2=\frac{[\sum i(Q_{m,i}-\bar{Q}_m)(Q_{s,i}-\bar{Q}_s)]^2}{\sum i(Q_{m,i}-\bar{Q}_m)^2\sum i(Q_{s,i}-\bar{Q}_s)^2}$$

$$\%Pbias=\left[\frac{\sum_{n=1}^{n}(Q_i-Q_s)*100}{\sum_{n=1}^{n}(Q_i)}\right]$$

Where Q is a variable of runoff and sediment yield, m and s are the measured and simulated variables and i is the measured or simulated data.

III. RESULTS AND DISCUSSIONS

K2 calibration was performed using the multiplier of Ks parameter M(Ks). The model relies on SCS method to calculate runoff [52]. It approaches runoff module based on Horton overland flow that occurs when rainfall exceeds infiltration capacity. The transport of solids is solved using finite difference techniques [53]. Runoff and sediment yield simulations were carried out using five storm events in order to compare the effect of rainfall duration and intensity on the basin hydrology as well as on the load conveyed towards the dam. The results in (Table 5), and (Figure 5 and 6) showed that there is a good agreement between observed and simulated values for the selected floods and the parameters adopted, although K2 seems to slightly underestimate runoff and to overestimate sometimes sediments yields. This is probably due to errors during model calibration phase. The implementation of KINEROS2 model offers the possibility to simulate variations in runoff at Tleta watershed as a function of rainfall amount and land cover.

Table 5. K2 observed Vs simulated results at Ibn Batouta [26]

	Events	Rainfall mm	Runoff (m^3)		NSE	R^2	Sediments (kg/s)		NSE	R^2
			Observed	Simulated			Observed	Simulated		
Calibration	24/12/2009	24	30 249	41 492	0.71	0.99	527	407	0.72	0.99
	03/02/1998	29	840 672	511 961			7 982	4 734		
	28/03/2004	21	113 184	52 524			281	695		
Validation	22/04/2003	27	254 880	300 984	0.98	0.99	1 544	2 785	0.97	0.99
	30/11/2012	28	389 664	477 692			3 291	5 130		
	06/01/2010	37	2 533 247	2 275 739			29 519	26 003		
	19/11/1999	15	3 455	586			9.91	15		

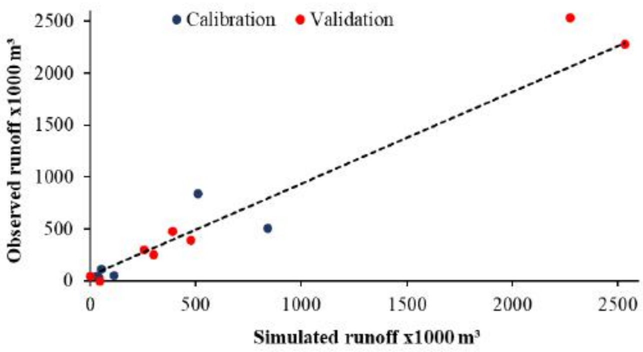


Fig.5: Observed and simulated runoff at Tleta watershed [26]

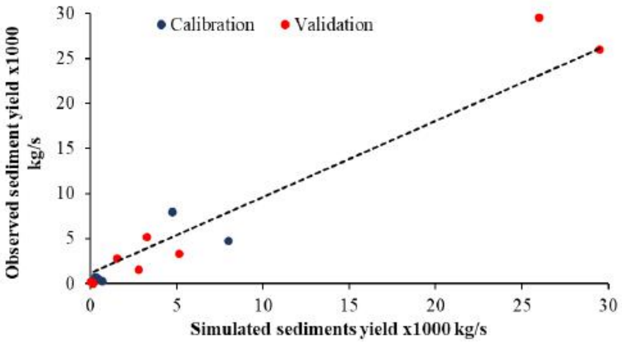


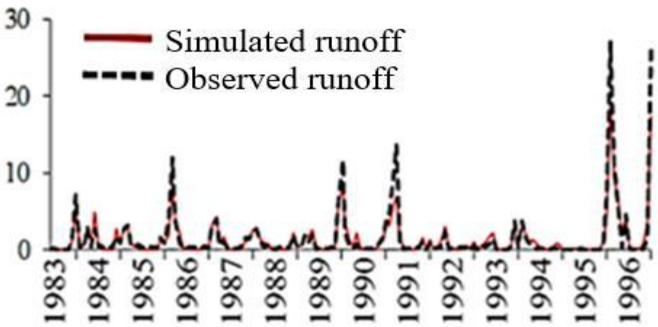
Fig.6: Observed and simulated sediment yields at Tleta watershed [26]

For SWAT model simulation, a good agreement has been achieved between simulated and observed runoff and sediment yields for monthly than for daily simulations (Table 6). The statistical validation criteria of the model also confirmed this agreement for both calibration (1983-1996) and validation period (1997-2010). The evaluation criteria used for the calibration of sediment load conveyed towards the outlet of the watershed are those of [54]. The results achieved are also satisfactory for the calibration and the validation periods, as it is shown in (Figure 7 and 8).

The assessment results attained by [32] allowed to highlight the capability of the model to estimate erosion parameters. Indeed, SWAT model seems to slightly underestimate daily runoff and erosion, and this is due possibly to errors during model calibration. The model appears to be more robust in the monthly forecasts than in the daily forecasts.

Table 6. SWAT daily and monthly simulations at Ibn Batouta dam [32]

Component	Time step	R^2		NSE		PBIAS (%)	
		Calibration	Validation	Calibration	Validation	Calibration	Validation
Runoff	Daily	**0.55**	**0.47**	**0.52**	**0.43**	**-2**	**-2**
	Monthly	**0.92**	**0.84**	**0.89**	**0.81**	**-3**	**-3**
Erosion	Daily	**0.56**	**0.40**	**0.40**	**-0.01**	**-10**	**-37**
	Monthly	**0.84**	**0.70**	**0.74**	**0.52**	**-10**	**-37**



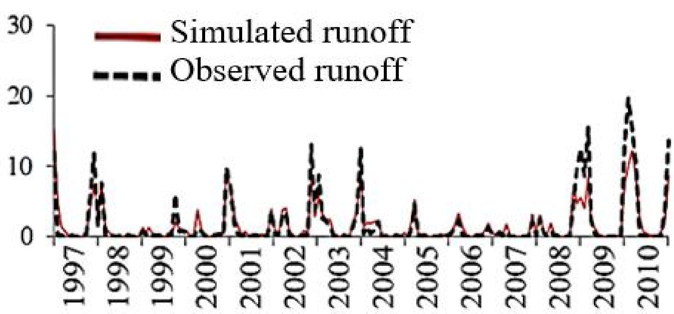


Fig.7: Observed and simulated SWAT monthly runoff (m3/s) [32]

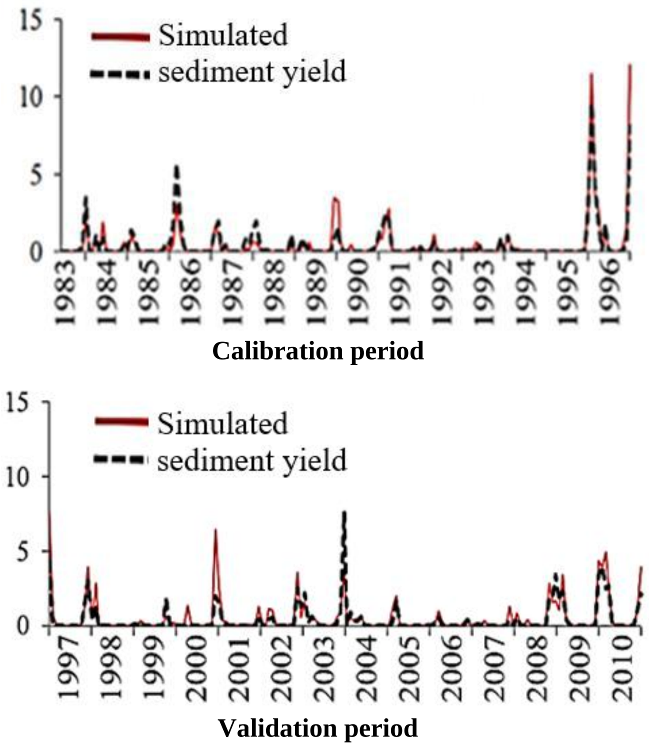


Fig.8: Observed and simulated SWAT monthly sediments yields (10^5tons) [32]

The Nash-Sutcliffe Simulation (NSE) and the coefficient of determination (R^2) for K2 and SWAT models were satisfactory (>0.5) when comparing observed with simulated data [55]. Both models appeared very stable, as (R^2=0.98 and NSE=0.99) for runoff K2 estimation and (R^2= 0.92 and NSE=0.89) for monthly SWAT results. A slight reduction in agreement between sediment yield was observed for SWAT (R^2=0.84 and NSE=0.74) and a better accuracy is noted for K2 (R^2=0.99 and NSE=0.97). Our findings are supported by [56], who demonstrated that SWAT model performance for the sediment yield simulation in Algeria with a R^2 of 0.76 and NSE of 0.75. A study by [57] analyzed the use of Nash as a goodness-of-fit measure for daily runoff simulation with SWAT, demonstrated that the monthly NSE corresponding with five studied versions of simulation model was 0.90.

From these results it can be concluded that the K2 model, coupled with AGWA, requires a small set of parameters, which is a great advantage for simple, fast and practical use. The results attained remain close to the field reality, which makes AGWA-K2 a functional coupling for integrated soil and water resource management in conjunction with sustainable use at the level of Tleta watershed.

The SWAT model is flexible and capable of using biogeographic information to simulate erosion parameters, but it is necessary to bear in mind that the setting of parameters affects infiltration/runoff partition, which requires a fine-tuning before [32]. Last but not least, the SWAT model appears to be more robust with monthly than with daily data (Table 6).

IV. CONCLUSION

In this study, the accuracy of KINEROS2 and SWAT models to simulate runoff and sediment yields was compared. It is concluded that the two models require specific measures for simulations and can simulate runoff and sediment yields in Tleta watershed.

Observed data from Tleta watershed were used for this comparison. To evaluate the performance of each model, the calibration was performed against the observed data. SWAT simulations were for the period 1983-2010. Even the events selected for K2 were included in the same period. The comparison of the simulated sediment yields during the calibration and validation periods leads to the conclusion that Kineros2 predictions are slightly better than Swat, with higher R2 and NSE values.

Based on the results, Kineros2 can be recommended for hydrological and sediment yield simulations. Indeed, the model has simulated the runoff and sediments more precisely than SWAT on a daily scale for the Tleta watershed. Swat includes many parameters to represent cycles, loss and transport by erosion. Calibrating these parameters in this model can be tedious and a lengthy process. In K2, most of the parameters are automatically generated from GIS data integrated in AGWA, or other information and relatively easy to adjust with appropriate instructions. It is also possible to couple SWAT with AGWA, this will minimize errors and time during the simulations. We suggest coupling the model with AGWA tool and then comparing the results obtained.

It should be noted that SWAT model addresses sheet and gully erosion compared to Kineros2 model who treats surface erosion, this type of erosion causes less damage and siltation of the dam.

Finally, to resume, the differences between the two models play a crucial role in their performance. This study revealed discrepancies between the simulation and operation processes of the two models. But the results confirmed their ability to infer the impact of water erosion on the entire watershed and select risk areas for future soil conservation planning.

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