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RIVERTWIN

A regional model for integrated water management in twinned river basins

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PU	Public	
PP	Restricted to other programme participants (including Commission Services)	X
RE	Restricted to group specified by the consortium (including Commission Services)	
CO	Confidential, only for members of the consortium (including Commission Services)	

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Introduction

Within the sixth Framework Programme (2002-2006) for the Research and the Technological Development in Europe of the European Commission; a consortium of institutions led by the University of Hoheinhem, Stuttgart initiated a research project in the thematic priority Sustainable Development, Global change and Ecosystems.

. The project “ **A Regional Model for Integrated Water Management in Twinned River Basins (RIVERTWIN)**” aims in adjusting and testing an integrated regional model for the strategic planning of water resources management in river basins taking into account the effects of global climate and land use change scenarios on the availability and quality of water bodies in humid tropical, humid temperate as well as semiarid regions

The regional model will take into account the impact of the population trends, the economic development and technological, the effect of the climatic change and use of the grounds on the availability and the quality of the hydraulic systems in moderated zones, subhumides tropical and semi arid.

The model will be developed in two European river basins with high data availability and data density and should include all relevant processes that are necessary for the description of water management its interactions with land use and climate change at the river basin scale, including water supply, water demand, water quality (biological, chemical), land cover/use, agricultural production, economic pressures/incentives, job and income generation and life quality. The transferability of the model to other ecological regions with low data availability will be tested in two third countries river basins under humid, tropical and semiarid, continental conditions. The second objective is the formulation of integrated scenarios of land use and climate change together with stakeholders in the respective river basins. The model will be used for scenario development in the respective river basins, taking into account potential changes in climate and land use as well as economic constraints at various spatial levels.

The experimental basins of RIVERTWIN project are :

- Neckar in Germany;
- Ouémé in Benin ,
- Chirchick in Ouzbékistan.

This report aims at presenting the hydrological data base of the basin of Ouémé. It constitutes the prelude to the hydrological information system that the Direction Générale de l’Hydraulique (ex-DH) plans to create for the rest of the hydrographic basins of the whole Benin

. This data base will be used for calibration of hydrological models and to their validation as well. The data base covers the following variables: sub-basins; rainfall, river discharges, static ground water levels, sediment transport and water quality

I. SUB-BASINS

The Ouémé catchment can be considered as the most important river basin in Benin by the proportion located on its territory among the different basins that it shares with other countries.

The Ouémé river takes its source in the area of Copargo-Djougou and flows into the Atlantic Ocean in the creek of Badagry in Nigeria. The main tributaries are Térou, Okpara and Zou. The division into different subbasins was carried to correspond to the distribution of hydrometric gages of the Hydrological Service.

The development of the integrated model, requiring sets of data of good quality, the hydrometric stations which were considered are:

- Ouémé at Affon,
- Wéwé at Wéwé,
- Yérou Maro at Barérou,
- Térou at Point 238,
- Beffa at Vossa,
- Adjiro at Banon,
- Ouémé at Savè,
- Zou at Atchérigbé,
- Okpara at Kaboua,
- Ouémé at Zagnanado,
- Zou at Domè,
- Ouémé at Bonou.

Figure 1.1 presents the basin of Ouémé and the subbasins considered within the framework of RIVERTWIN.

The surfaces of the various sub-basins are given in table 1.1. The delineation of the sub-basins was carried out from the treatment of the digital elevation models (DEM) obtained from projectIMPETUS. The values of the area obtained from the former topographic charts are given on a purely comparative basis.

Table 1.1: Surfaces of the sub-basins

Sub-basins	Previous area (km ²)	New area (km ²)	Deviation (%)
Ouémé at Affon	1165	1181	1,4
Wéwé at Wéwé	293	260	11,3
Yérou Maro at Barérou	2162	2125	1,7
Térou at Point 238	3133	3059	2,4
Ouémé at Bétérou	10475	10076	3,8
Beffa at Vossa	1870	1934	3,4
Adjiro at Banon	1408	1063	24,5
Ouémé at Savè	24800	23491	5,3
Zou at Atchérigbé	6950	7034	1,2
Okpara at Kaboua	9600	9463	1,4
Ouémé at Zagnanado	37850	38155	0,8
Zou at Domè	8210	8307	1,2
Ouémé at Bonou	46990	47541	1,2

Apart from Wéwé at Wéwé, and Adjiro at Banon, the deviations in the area are minimal on all the tributaries and reasonable on the principal course of Ouémé: 5,3 % at Savè, 0,8 % at Zagnanado and 1,2 % at Bonou.

Figure 1.1: Sub-basins of Ouémé catchment



II. RAINFALL

The network of rainfall gages and recorders of the Ouémé basin is managed by the Meteorological Department. However a complementary network belongs to different CeRPA (Regional Centre for Agricultural Promotion). The data of the stations of CeRPA are taken into account to supply the basic stations in case of incompleteness. They have been sufficiently presented in the report (Deliverable 15) of Dr. IGUE within the framework of RIVERTWIN.

The number of rainfall gage stations amounts to 19 for a total amount of almost 1064 station years.

Table 2.1 gives the geographical co-ordinates of the rainfall gages of the Ouémé basin. Figure 2.1 presents the location of the rainfall gages in the basin.

Table 2.1: Rainfall gages in Ouémé basin

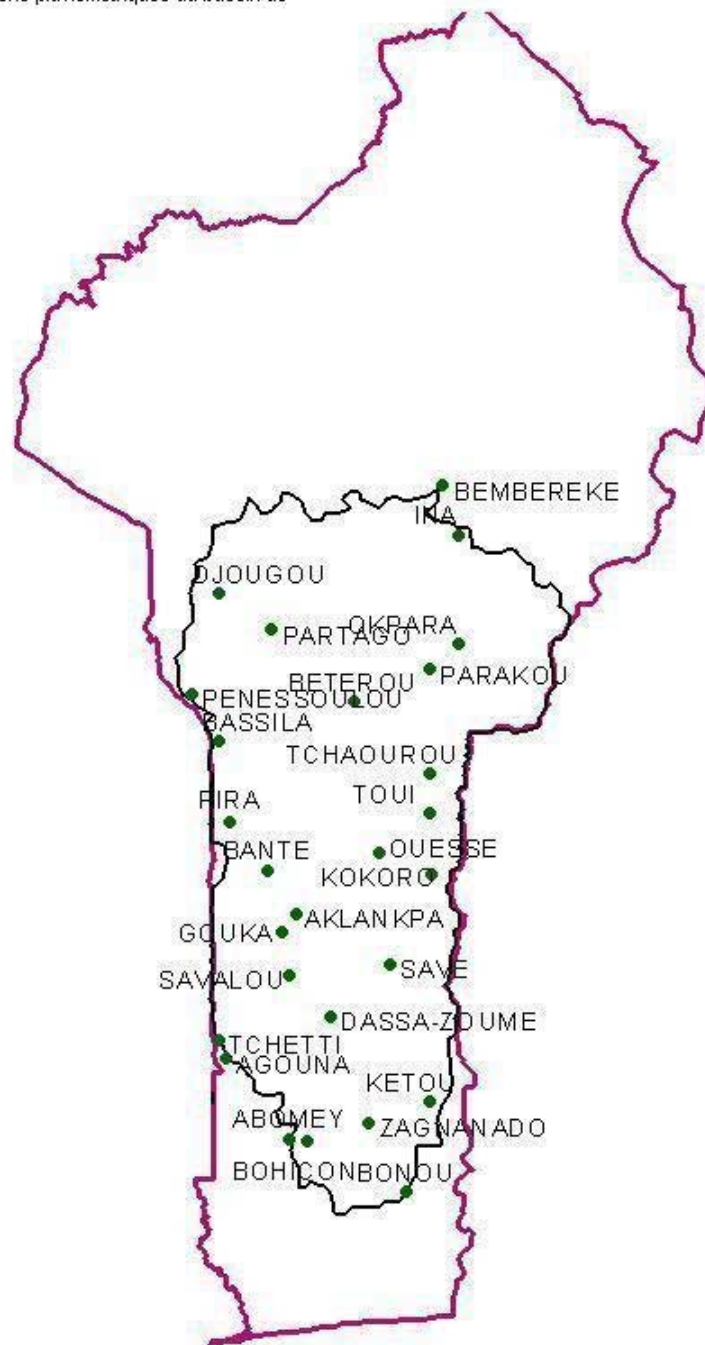
Rainfall gages	Latitude	Longitude	Nature	Series
Agouna	07°33'	01°42'	P	1980-2003
Bantè	08°26'	01°53'	Clim	1942-2000
Bassila	09°01'	01°40'	P	1950-1996
Bétérou	09°12'	02°16'	P	1953-1999
Dassa-Zoumè	07°45'	02°10'	P	1941-1999
Djougou	09°42'	01°40'	Clim	1921-2000
Kétou	07°21'	02°36'	P	1950-1999
N'Dali	09°51'N	02°42'E	P	1969-1999
Nikki	09°36'N	03°12'E	P	1921-2003
Okpara	09°28'N	02°44'E	P	1956-2003
Ouèssè	08°30'N	02°23'E	P	1964-2003
Parakou	09°21'N	02°37'E	Syno	1921-2000
Partago	09°32'N	01°54'E	P	1969-2003
Savalou	07°36'N	01°59'E	Clim	1921-2003
Savè	08°02'N	02°28'E	Syno	1937-2003
Tchaourou	08°52'N	02°36'E	P	1937-2003
Tchetti	07°49'N	01°40'E	P	1964-2002
Toui	08°41'N	02°35'E	P	1944-2003
Zagnanado	07°15'N	02°20'E	P	1921-2003

P: rain gage; Clim: climatological ; Syno: synoptic

At this stage of the development of the data base, certain data of the rain gages of Aklampa, Ouinhi, Pénéssoulou, Pira were not accessible. In addition the peripheral rain gages of the basin would be useful for the data base. It is the case of the rain gages of Bembérékè, Sèmèrè and Nikki. It is the same for the synoptic station of Bohicon. The tables of the monthly values of rain are given in appendix 1 on the attached CD.

Figure 2.2 : Rain gages network in Oueme basin

Figure 2.2: Stations pluviométriques du bassin de l'Ouémé



III. RIVER FLOWS

The hydrometric network which allows the follow-up of the flows of the rivers of the basin of Ouémé is maintained by the Hydrological Service of the Water Resources Department. The principal stations are: Ouémé at Savè, Ouémé at Bétérou, Ouémé at Zagnanado, Ouémé at Bonou, Zou at Atchéribé and Okpara at Kaboua. The series of flows are longer there.

Most of the stations were created in the 1950's. Today, they all are equipped with automatic recorders. Other stations have been created recently. It is particularly the case of the stations of upper Ouémé in the years 1980' within the framework of the Onchocercosis Control Programme (OCP) of the World Health Organization. The flow gage of Zagnanado was set in 1986, to supply the frequent change in the rating curve at the gage of Sagon. Despite of its recent creation, it presents enough gaps due to the operation problems of the various equipment. To compensate the shortness of the length of its series, the data of the old station of Sagon are proposed. Indeed the station of Sagon is located just at a few ten kilometers downstream and has a series going from 1951 to 1984.

Table 3.1 presents the list of the hydrometric stations

Stations	Latitude	Longitude	Length of series
Ouémé at Affon	09°45'N	02°06'E	1981-2003
Wéwé at Wéwé	09°23'N	02°06'E	1961- 2003
Yérou-Marou at Barérou	09°21'N	02°22'E	1981- 2003
Térou at cote 238 (piste Okoto)	09°05'N	02°05'E	1983- 2005
Ouémé at Bétérou	09°12'N	02°13'E	1952- 2005
Beffa at Vossa	08°30'N	02°21'E	1983-2003
Adjiro at Banon	08°34'N	01°56'E	1981-2002
Ouémé at Savè	08°00'N	02°25'E	1951-2002
Zou at Atchéribé	07°32'N	02°02'E	1951-2002
Okpara at Kaboua	08°15'N	02°43E	1960- 2003
Ouémé at Zagnanado	07°13'N	02°28'E	1986-2003
Ouémé at Sagon	07°10N	02°26'E	1951-1987
Zou at Domè	07°07'N	02°20'E	1961-2005
Ouémé at Bonou	06°54'N	02°27'E	1960-2002

The monthly values of discharges at these flow gages are given in appendix 2.

IV. PIEZOMETRIC LEVELS

The piezometric network in Benin is still embryonic. It was first installed in the sedimentary zones because of recognized hydraulic continuity with these mediums. But taking into account the extent of the phenomenon to be followed, the network extended to the crystalline zone. In the department of Zou, eight (08) old piezometers were rehabilitated in 2002. The list of these piezometers appears in table 4.1 below.

Table 4.1: Piezometers rehabilitated in the department of Zou

N°	Commune	Locality	Coordinates		Depth (m)	S.L (m)	Altitude. (m) (to verify)	Number
			X	Y				
1	Bohicon	SH	2° 03' 13"	7°10' 25"	53.52	66.31	170	1
2	Abomey	Gbéizankon	2° 00' 13"	7° 08' 13"	65.28	76.18	168	1
3	Za-kpota	Adjido-Djevo	2°12' 03"	7°12' 07"	41.73	59.00	110	1
4	Zogbodomey	Yokon	2° 09' 01"	7°10' 25"	17.47 (P) 17.12 (F)	78.00	50	2
5	Zogbodomey	Samionta ou Azozezon	2° 15' 07"	7° 05'43"	17.65	78.00	40	1
6	Covè	Lainta	2° 20' 32"	7°10' 57"	15.44 (P) 15.59 (F)	34.50	60	2

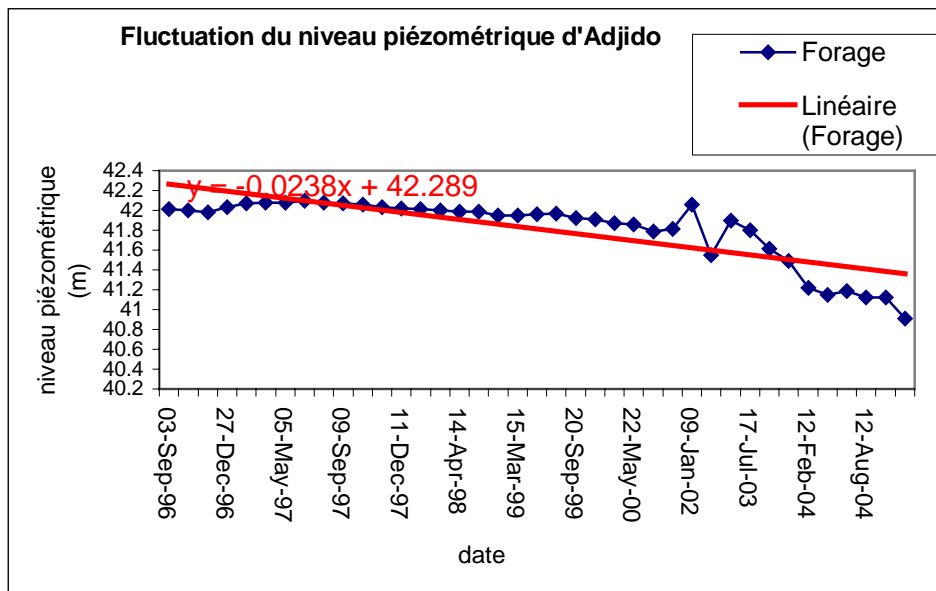
Table 4.2 presents piezometers in the department of the Collines.

Table 4.2 : Piezometers in Département des Collines

N° Piézo	COMMUNE	Locality	Coordinates		Depth (m)	Static level (m)	Altitude (to verify) (m)	Number
			X	Y				
1	OUESSE	Danigbé	2°26'27.3"	8°29'15,8"	42,95	5.85	248	1
2	SAVE	Djangbé II	2°30'29.1"	8°01'37.3"	55,42	2.44	196.8	1
3	GLAZOUE	Ayédéro II	2°14'43,6"	7°58'27,2"	35,43	1.81	177.8	1
4	BANTE	Assaba	1°58'46,6"	8°22'23.0"	49,22	18.12	226	1
5	SAVALOU	Gbaffo-Dogoudo	1°58'49.0"	7°55'48.0"	43,67	1.57	165	1
6	DASSA-ZOUME	Mahu	2°06'46.0"	7°49'30.8"	65,78	9.39	157	1

Figure 4.1 gives the trend of the static level of the water table at Adjido. The measurements of static level done at the different piézometers are given in annex 3 on the attached CD.

Figure 4.1: Trend in water table at Adjido



V. THE SEDIMENT TRANSPORTATION

The measurement of sediment transportation by the Hydrological Service is a recent activity. It started in 2004. It covers some stations of the basins of the Ouémé, the Mono and the Couffo. The data at the gages of Bonou, Zagnanado, Savè, Atchéribé and Kaboua are given in appendix 4 on the attached CD.

VI. THE QUALITY OF WATERS

The Service of Water Quality of the Water Resources Department analyses waters of boreholes and wells before the first delivery in consumption of these waters. From this fact it has an important mass of data on the underground waters.

On the other hand, data of quality for the surface waters particularly those of the rivers, are almost inexistent. Thanks to RIVERTWIN project; measurement of quality of the waters of the rivers have been undertaken on hydrometric gages by the FSA team of the project. These measures only started in 2004 and it is hoped that they continue in the setting of the activity plan of the Water Resources Department (DRE). The results of analyses of waters at the hydrometric gages both in surface waters and from boreholes and wells are given in appendix 5 (attached CD).

VII. CONCLUSION

The present report is the D14 deliverable of the project. At this stage the data of some rain fall gages surrounding Ouémé basin were not accessible. Concerning the river flow, the series station of Zagnanado can be extended using the data of Sagon. Concerning the data of quality and sediment transportation and piézométry, it can be noted that the sets are short because the collection is recent.

Appendix 1 : Series of monthly precipitation

Appendix 2 : River discharge series

Appendix 3 : Data base of wells in the Oueme basin

Appendix 4 : Sediment concentration at five river gages in the Oueme basin

Appendix 5 : Data base on chemical water quality measurements in the Oueme basin