

A DGPS-METHOD TO MEASURE SEDIMENT ACCUMULATION RATES IN WSPs. APPLICATION IN TUNISIA

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Introduction

Usually WSP systems have several ponds in series.

Portions of the influent SS but also of the biomass (bacteria and algae) produced in the reactor will settle in the ponds.

The sediments also gradually reduce the active volume of the ponds and the shape of the bottom as well which may result in less efficiency.

At the bottom various processes occur in those sediments: organic compound and nutrient exchanges with the overlying liquid phase, oxygen consumption in the upper layer, compression and anaerobic processes, etc.

Introduction

Removal has to be organized periodically, but the period needs to be defined properly to reduce operating costs.

Specific accumulation rates per capita have been suggested in the literature to help with those tasks.

The spatial distribution of deposits is usually uneven and related to the geometry of the ponds

It is thus important to get a map of the deposits, as depth variations have frequently been observed most of the sediments accumulating near the ponds' inlets and outlets.

Explanations have been proposed in literature

Introduction

Studies have described the accumulation rates expressed as cm/year (usually in the range of 1 to 5) or as m³/year per capita (in the range of 0.02 to 0.06) or better as kg SS /year and per capita.

As the deposits may have a very uneven spatial distribution, a careful sampling procedure has to be defined to get accurate average values for the ponds.

Moreover PICOT *et al* (2005) have shown that due to the slow anaerobic processes, the volume of deposits decreases slowly with time, so it is also important to know the age of the pond to analyze the results.

Introduction

In most cases the depth of the deposit is measured manually. A grid is drawn for the pond and measurements are located on the grid to facilitate maps.

Examples can be found in KEFFALA *et al.* (2008). When the grid's cell size is small, the amount of work becomes tremendous.

In this paper we describe a new method based on two DGPS receivers linked to an echo sounder that can greatly facilitate the task.

MATERIALS AND METHODS

To solve the time-consuming problem of manual measurement we set up a DGPS system yielding a precision of approximately 1 cm horizontally.

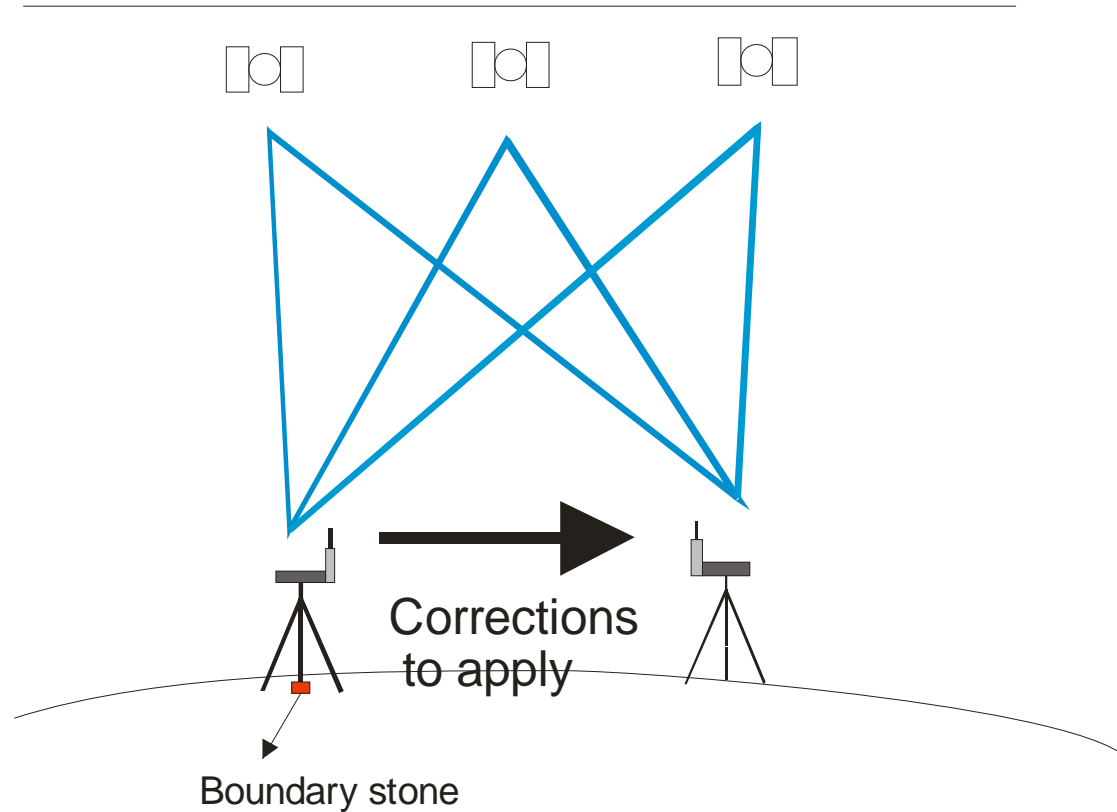
The system is composed of two GPS receivers (Leica system 1200 and antenna AX 1202 GG).

The first one, located on a defined point selected to find many satellites signals, is used to calculate errors.

The second is moved around the pond to measure the area directly (topographic measure of the embankment).

The two GPSs communicate by radio modem (RTK Real Time Kinematic configuration)

MATERIALS AND METHODS



Principle of DGPS measurements

MATERIALS AND METHODS

To get X and Y positions on the pond : Part 1



reference station

***Reference station: calculation of error
and link by radio modem***

MATERIALS AND METHODS

To get X and Y positions on the pond : Part 1



***Rover in portable configuration, embankment (topographic survey)
Aghir WWTP and Gammarth***

MATERIALS AND METHODS

To get X and Y positions on the pond : Part 2



Rover in echo sounding configuration on Gammarth's first basin



Echo sounding at El Jem: system configuration. The GPS antenna is clearly visible

MATERIALS AND METHODS

To get Z positions in the pond

An echo sounder (Tritech Model PA 500) is also located on the boat.

A dedicated software has been developed in the lab to communicate directly between the DGPS and the echo sounder.

The echo sounder measures the depth (Z) of the sediment at given time intervals (1 sec).

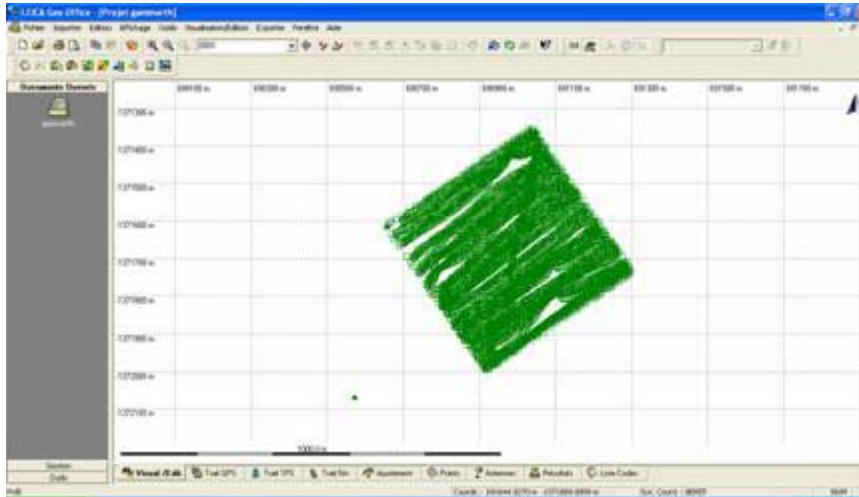
It simultaneously sends a signal to the DGPS, which will calculate the other coordinates (X,Y) of the point.



FIRST EXAMPLES

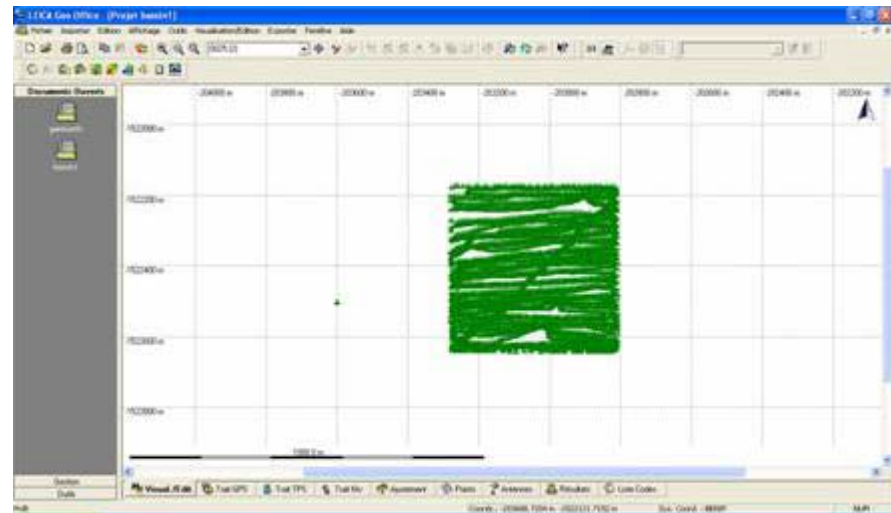
Treatment plant	Since	Type of lagoon	Nominal hydraulic load m³/d	Nominal load (kgBOD/d)	Actual conditions (m³/d)	Actual conditions (kgBOD/d)	Number of PE	Volume m³	Surface area m²
Gammarth lag2	1981	(Aerated) facultative	7875	2500	8200	2732	50600	609200	222300
El-Jem	1994	natural	1250	600	1027	440	8148	9592	9400

DATA PROCESSING



The data points in Leica Geooffice®.

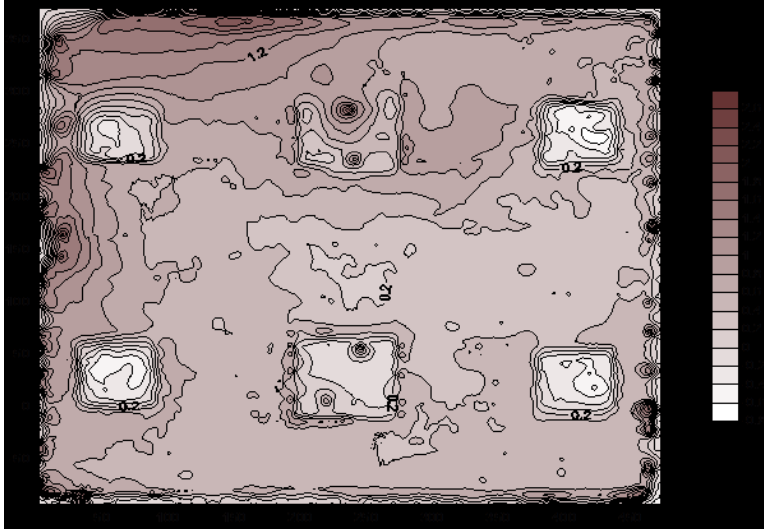
Rotation of the data points in Leica Geooffice®.



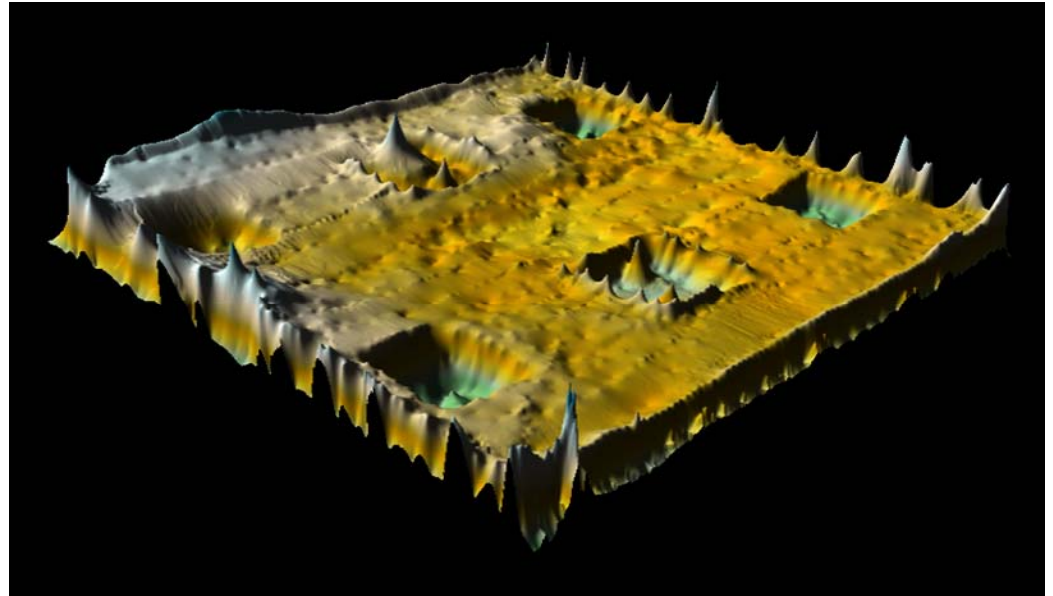
DATA PROCESSING : SURFER 9.01

This software allows interpolation by Surfer® 9.01. The method produces visually appealing maps from irregularly spaced data, yielding here a final matrix of 474 rows x 471 columns, thus 223 254 data points.

RESULTS IN GAMMARTH



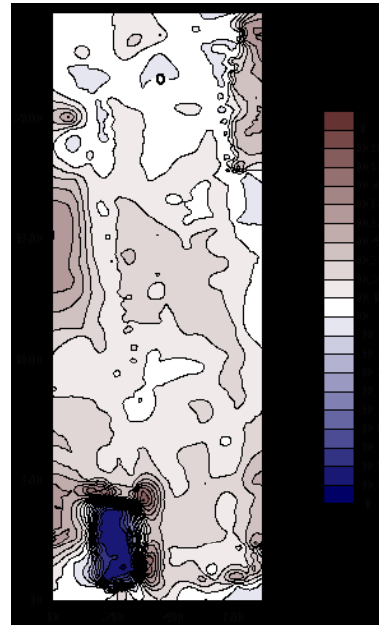
*Map of Gammarth basin N°2;
distance between isolines is 0.2 m*



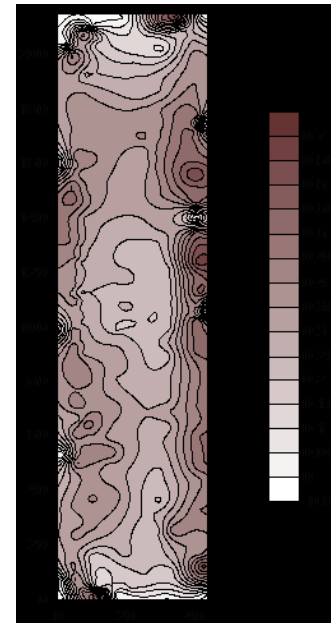
Stereoscopic map of Gammarth Basin 2

Sediment volume is calculated by integration (Simpson or trapezoidal method) with a boundary horizontal section at the bottom of the basin

EXAMPLE OF EL JEM



Basin 1



Basin 2



Basin 3

Iso-depth values (equidistances are expressed in m)

SUMMARY OF RESULTS

Basin	Volume of sediments m³	Pond area m²	Pond depth m	Average deposit m	Max deposit level m	Accumulation rate I/PE.year
Gammarth B2	122905	222320	2.74	0.55	2.52	93
El Jem B1	2608	16953	1.3	0.15	0.92	25
El Jem B2	3034	9404	1.02	0.32	0.68	29
El Jem B3	3787	10731	1.17	0.35	0.86	36
Total for El Jem	9429	37088				89

CONCLUSIONS

- The methodology presented has proven to be much faster than the traditional technique. The Gammarth second aerated pond (22 ha) was measured (5500 data points) in only one day, including the time needed for topography.
- The three ponds of El Jem were also measured in less than one day.
- Precision is better than that of the traditional technique, for two reasons:
 - The XYZ position error is centimetric
 - The number of recorded points is very high, so the extrapolation is better.

Moreover the monitoring steps are numeric and automatic, which avoids transcription errors.

CONCLUSIONS

- The values calculated for Gammarth Pond No. 2, which is an aerated lagoon, and the whole El Jem treatment plant are in the range found in the literature (40-100 l/PE.year) (KEFFALA *et al*, 2008).
- In a future paper we shall compare the RTK method of DGPS with a post-treatment method requiring a cheaper investment.
- The method is now being applied in various types of ponds to get data to help the management of pond sludge in Tunisia

ACKNOWLEDGMENT

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