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ASSESSMENT OF THE TRANSFERRED WATER INFILTRATION IN THE MANAGEMENT OF A MEDITERRANEAN MAN-MAINTAINED WETLAND: LAS TABLAS DE DAIMIEL NATIONAL PARK (SPAIN)

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Abstract. Las Tablas de Daimiel National Park wetlands (Central Spain) have had their main origin in the West La Mancha aquifer discharges. Inflows into these wetlands ceased due to the intensive aquifer exploitation. A progressive deterioration of the wetland brought about several attempts of remedial actions by means of building several small dams and pumping groundwater to the Las Tablas basin. The main attempt to preserve these wetlands has been made by means of the inter-basins transfers. However, a part of these water transfers is lost within the wetland basin due to the infiltration into the underlying aquifer. Infiltration becomes an essential parameter in any study related to the attempts at keeping some water in the basin and, therefore, in the integrated management of the water resources systems related to the wetland. The actual extent of these losses is difficult to quantify due to the poor quality of existing data as well as to the lack of determination of various important parameters. A methodology based on daily water balances in the wetland basin allows to assess that losses and can be used for the National Park water management.

Key words: inter-basins diversion, water losses, water management, wetlands.

Abstrakt. Pochodzenie bagien Parku Narodowego Las Tablas de Daimiel w środkowej Hiszpanii jest związane z wypływem wód podziemnych ze zbiornika regionu zachodniego La Mancha. Wypływ tych wód do bagien zmalał z powodu intensywnej eksploatacji zbiornika. Postępujący zanik bagien skłonił do podjęcia działań zapobiegawczych, w postaci budowy szeregu małych zapór i przepompowywania wody do basenu Las Tablas. Głównym przedsięwzięciem zmierzającym do ratowania bagien było przesyłanie wody z innych basenów, jednak jej część była tracona w obrębie basenu bagiennego, ze względu na infiltrowanie do leżącego niżej zbiornika wód podziemnych. Infiltracja ta stała się ważnym parametrem przy projektowaniu metod utrzymania wody w basenie bagiennym, a także przy zintegrowanym zarządzaniu zasobami wodnymi, związanymi z obszarami bagiennymi. Rzeczywisty rozmiar strat jest trudny do określenia zarówno ze względu na złą jakość istniejących danych, jak i braku określenia różnych ważnych parametrów. Metodyka badań oparta na dziennym bilansie wód w basenie bagiennym pozwala określać te straty i może być stosowana przy zarządzaniu wodami Parku Narodowego.

Słowa kluczowe: przepływy międzybasenowe, straty wód, zarządzanie wodą, bagna.

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INTRODUCTION

Las Tablas de Daimiel National Park wetland is situated in the central area of the Iberian Peninsula (Fig. 1). It was naturally fed both by groundwater from the West La Mancha aquifer and irregular superficial discharges. Due to its geographical position, it has a great ecological importance for migration and nesting of birds, having been declared the National Park in 1973, the Reserve of the Biosphere in 1981, and placed on the Ramsar list in 1982 (García Rodríguez, 1996; Cruces, Martínez Cortina, 2000).

However, its natural specifics and characteristics have been largely disturbed by anthropogenic actions (García Rodríguez, 1996; Álvarez-Cobelas *et al.*, 2001). An intensive exploitation of the West La Mancha aquifer (over 5,000 Mm^2) resulted in an important groundwater depletion. Thus, a decline in piezometric levels and a decreasing, and even disappearance of the discharges in the springs that fed Las Tablas, led to the complete drying out of the wetland in 1987 (García Jiménez *et al.*, 1992).

The progressive deterioration of the wetland brought about several attempts of remedial actions (Sánchez Soler, Carrasco, 1996) by means of building several small dams, pumping groundwater to Las Tablas Basin and, more significantly, transferring surface water from the Tajo Basin (Fig. 1). Transferred water makes use of infrastructures of a previous inter-basin diversion which connects Tajo and Segura Basin, and were built across some tributary streams of Las Tablas.

Because the wetland is currently topographically higher than the aquifer water table (García Rodríguez, Llamas, 1996), part of the water poured into Las Tablas (pumped water, natural surface discharges and transferred water from Tajo Basin) infiltrates and feeds the aquifer. Therefore, the wetland is considered a "gigantic recharge pond" (Llamas, 1989, 1991).

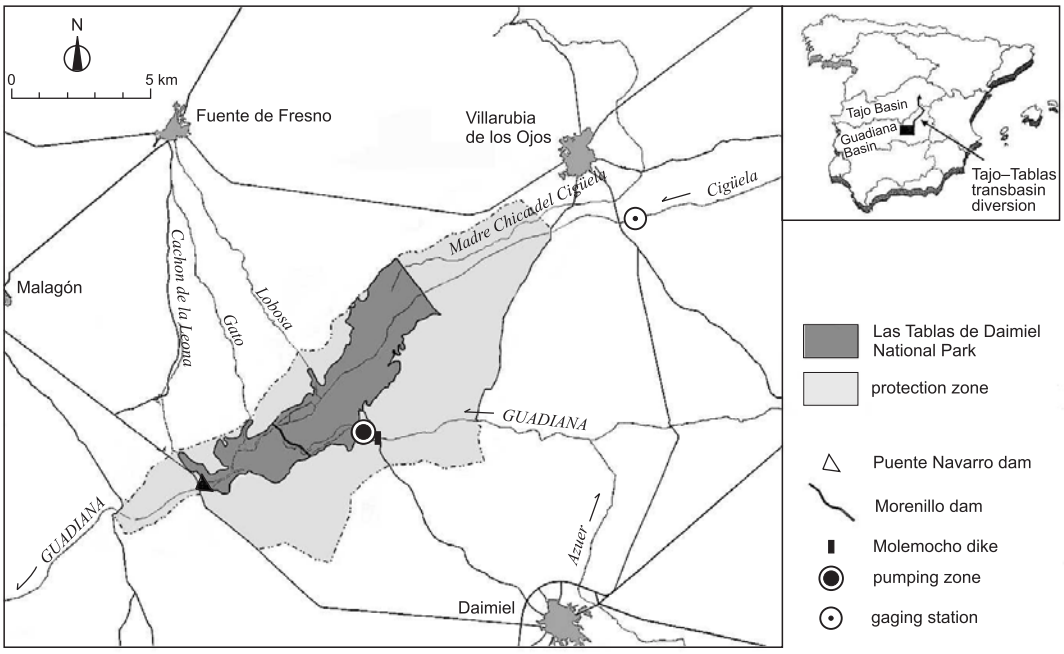

Fig. 1. Location of Las Tablas de Daimiel National Park and some of the elements influencing its water balance (after Martínez-Alfaro, Castaño, 2001, modified)

ASSESSMENT OF THE INFILTRATION AND POND AREA

Infiltration becomes an essential parameter in any study related to the attempts of keeping some water in the basin and, therefore, in the integral management of water resources systems related with the wetland. Several attempts have been made to calculate the amount of infiltration from the water balance in Las Tablas de Daimiel, but most of them were general and considered periods with low abstractions from the aquifer, only.

Martínez-Alfaro and Castaño (2001) have developed an assessment methodology of the preliminary infiltration coefficient. It involved daily water balances considering the geometry of the basin and the flooded area. The methodology was ap-

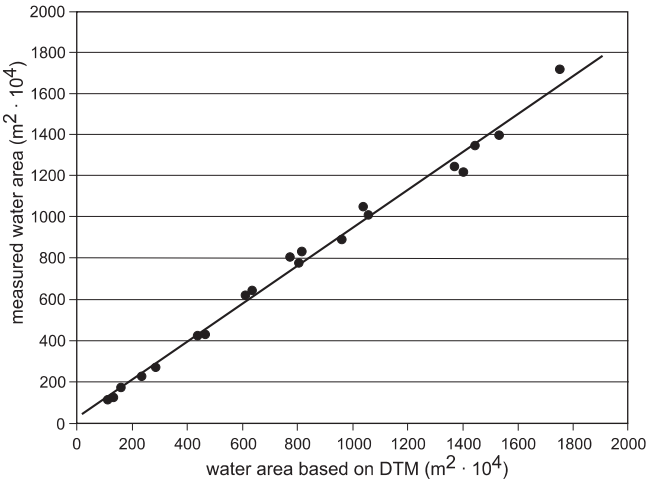

Fig. 2. Comparison between observed and estimated flooded areas considering a 10 mm/d infiltration coefficient

plied for the 1996 (when water from Tajo Basin was transferred to Las Tablas) and 1997 years (when an extraordinary surface runoff occurred), when the water regime was already influenced by abstractions from the aquifer. The calculated infiltration coefficient was 10 mm/d (Fig. 2).

Complementarily, specialised software for parameter estimation (PEST, Watermark, 1998) has been applied to a specific program designed to calculate the water balance in Las Tablas. The estimated parameters were an infiltration coefficient and some geometrical values. The results were similar to that received from the preliminary balance (Fig. 3).

Due to the fact that the balance has used the relationship between storage capacity of the basin and the flooded area, the program could be utilised for the water management in the National Park, the main variable for the ecological functions of the wetland. Moreover, it can be used for the management of both the underlying aquifer, where a part of the infiltrated water recharges to, and of the Tajo Basin system where the transferred water comes from.

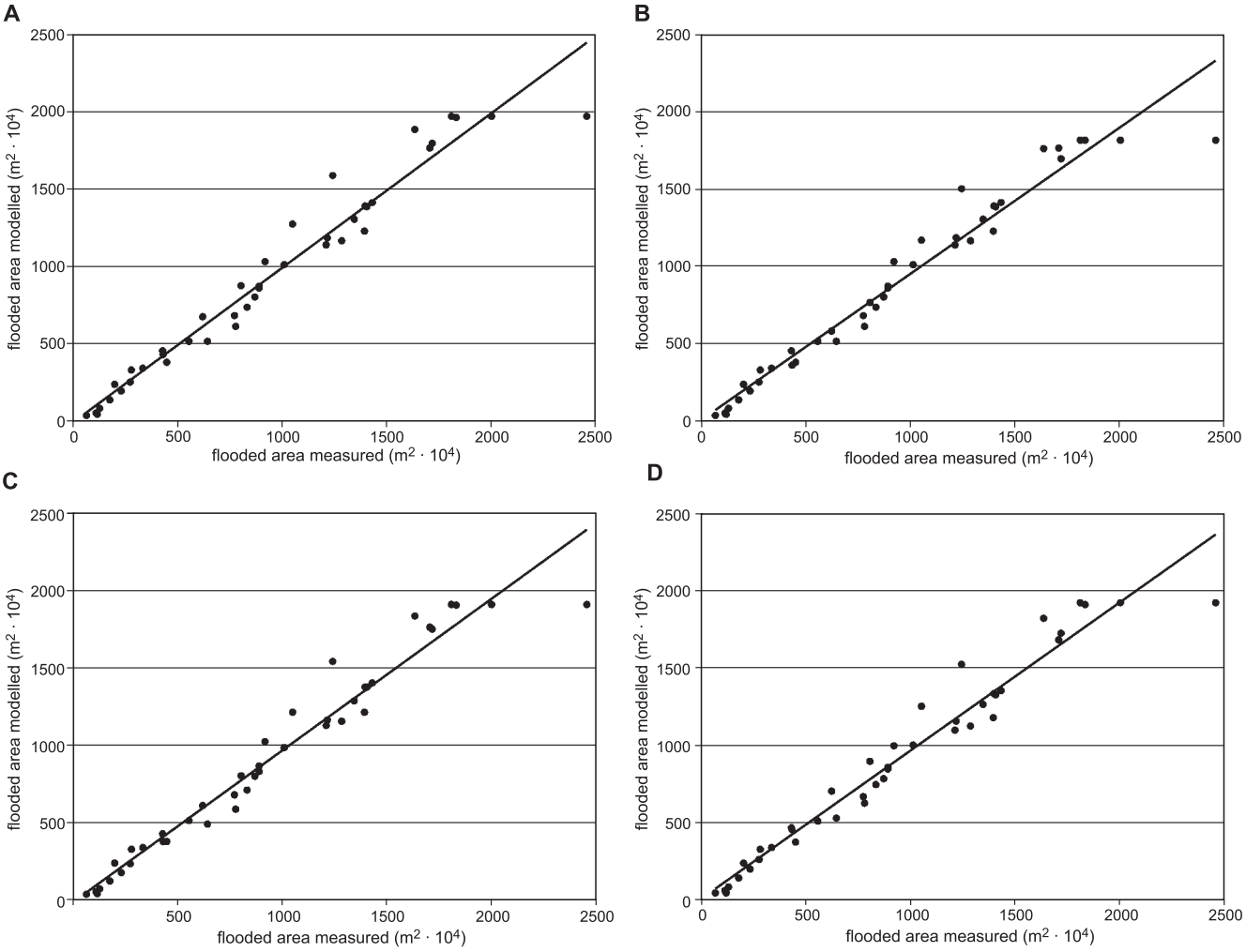

Fig. 3. Comparison between measured and calculated flooded surface values for the estimation of different parameters influencing Las Tablas de Daimiel water balance

Simulations: **A** – PEST01, **B** – PEST02, **C** – PEST03, **D** – PEST04

Table 1

Comparison between calculated and observed maximum flood area and percentage of days with pond-building surface areas exceeding two critical values

Estimation	Maximum flooded area ($m^2 \cdot 10^4$)	Maximum flood date	Difference with measured (%)	% days flooded area >600 $m^2 \cdot 10^4$ (%)	% days flooded area >850 $m^2 \cdot 10^4$ (%)
PEST00	1412	05/25/1996	1.40	52.19	41.24
PEST01	1425	05/25/1996	0.49	53.28	41.97
PEST02	1425	05/25/1996	0.49	52.90	41.67
PEST03	1412	05/25/1996	1.40	52.19	41.24
PEST04	1356	05/26/1996	5.31	52.92	41.24
Measured	1432	05/29/1996		62.96	48,15

Note: Only 27 flooded area measures in 274 days from 1st January to 30th September 1996

Table 1 compares the measured data of flooded area and those obtained by means of preliminary balance and PEST program estimations from January to September 1996, when the whole surface input came from Tajo Basin. The table shows the maximum flooded area and percentage of days when the pond surface is larger than 6,000,000 m^2 and 8,500,000 m^2. Managers consider these values as critical for the optimal ecological function of the National Park (Berzal *et al*., 1987).

The results are similar in almost all simulations, except for PEST04, where parameters of the relationships between storage capacities and flooded areas of the wetland basin were estimated. The use of only an infiltration coefficient for both natural and artificial pond-building periods makes the difference between both modelled and observed values. However, that difference can not be considered significant for the water management in the National Park.

CONCLUSIONS

The most important wetland in Central Iberian Peninsula is artificially maintained by means of transferred water from an external basin, which partly infiltrates to the underlying permeable formations. Using a methodology based on daily water balances, it is possible to predict the near-real flooded surface and then to apply other additional remedial actions, if necessary, to improve conditions for both flora and fauna of the National Park.

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