



Modeling the Hydrological Regime of the Tenagi Plains Basin for the Hydrological Year 2024/2025 [†]

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Abstract

The Tenagi Plains Basin periodically suffers either severe flooding or drought conditions especially due to the lack of both sufficient and proper water management infrastructure works, whilst at the same time playing a vital role for the survival and development of agriculture within its incorporated areas in Paggaion Municipality, Kavala Prefecture, Greece. Moreover, due to its limited reservoir storing capacity within its upper catchment area, some dams of relatively small capacity are suggested to be taking advantage of the great water resources regime of the entire watershed area, especially during hydrological years of increased rainfall. The present study, using hydrological modeling (“HEC-HMS” and Geographical Information Systems), explores the total water quantities of the entire watershed that would have been effectively controlled during the hydrological year 2024–2025.

Keywords: Tenagi Plains; dam; modeling; hydrological regime

1. Introduction

Adequate water availability is of ultimate importance for decentralized rural sustainable development, including sufficient and survival-focused crops yield. Within this context, water reservoirs and dams play an important role in ensuring adequate water abundance.

Limited recorded rainfall analysis and simulation as well as real-time stream flow (discharge) measurements have taken place so far within the area of the Prefecture of Kavala, the Region of Eastern Macedonia and Thrace, North-eastern Greece [1–3]; thus, online data of this type were not possible to be discovered and accessed, pertinent to “Tenagi Plains Main Draining Ditch”, especially regarding the specific site where the “Simvoli” dam (supporting mainly an irrigation water-distribution role) has been constructed.

The purpose of the present work is to reveal the importance of the total water quantities Greece has controlled by means of the “Simvoli” dam/“Tenagi Plains Main Draining Ditch” catchment area (watershed), if considered (not for the purpose of the present study) together with the “Aggitis River Basin”, which incorporates Municipalities of Kavala, Paggaion and Nestos/Prefecture of Kavala, Municipalities of Drama, Paraneion, Prosotsani and Doxaton/Prefecture of Drama/Region of Eastern Macedonia and Thrace and Municipalities of Amphipolis and Nea Zichni/Prefecture of Serres/Region of Central



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Macedonia. The hydrological regime refers to the hydrological year 2024–2025 and part of the hydrological year 2025–2026 by means of hydrological modeling (“Hydrologic Engineering Center—Hydrologic Monitoring Center”, briefly referred to as “H.E.C.-H.M.S.” (v.4.12, 609 Second Street, Davis, CA 95616–4687) and “Geographical Information Systems” tools, briefly referred to as “G.I.S.” systems).

2. Study Area

The catchment area (watershed) of the above-mentioned dam is depicted below, within the environment of “Q.G.I.S.” v.3.26.3 and “Google Earth Explorer” version 7.3.7.1155 (64-bit) (Figure 1a,b). On the left lies the map produced by “Q.G.I.S.” depicting the specific “Simvoli” dam’s catchment area (watershed), which is demonstrated by the green-colored, clearly defined outline; simultaneously, the dam construction site is depicted by a relatively thematic block symbol (retaining wall with water from one side, shown altogether in black) as well as the respective river network (blue-colored lines with width attributed in relation to the order each stream possesses within the river network it belongs to, in accordance with the “Strahler” water stream order classification method) (Figure 1a). On the right, in the same way as the abovementioned way, lies the map produced by “Google Earth Explorer” where the same dam is demonstrated; simultaneously, the proposed dam construction site is depicted by a yellow-colored pin symbol as well as the respective river network (white-colored lines with the same width attributed regardless of the order each stream possesses within the river network it belongs to, in accordance with the “Strahler” water stream order classification method) (Figure 1b).

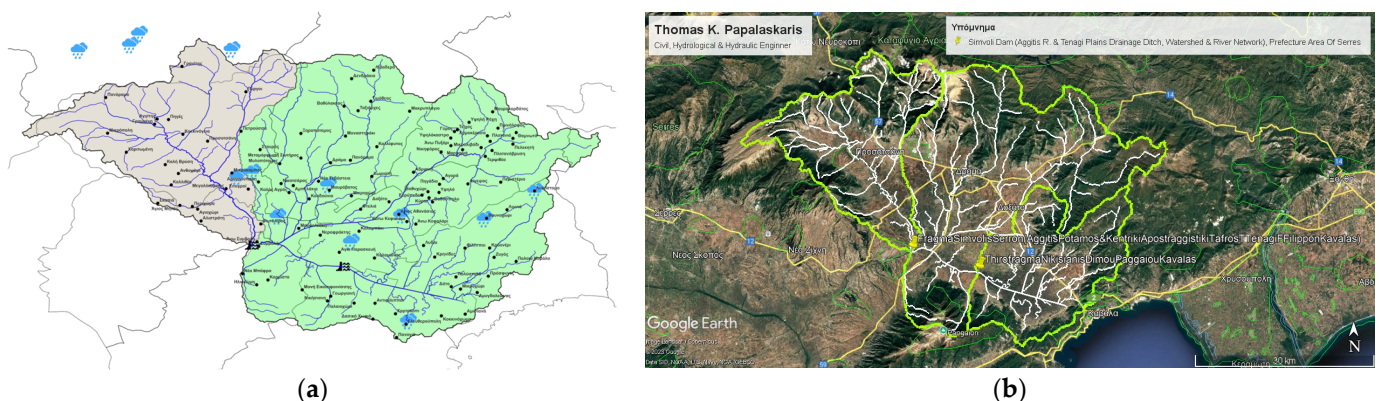


Figure 1. (a) “Q.G.I.S.” map illustrating the specific studied dam (clearly defined perimeter outline), catchment area (watershed) (“Tenagi Plains Main Draining Ditch” watershed is green-colored and “Aggitis River” is pink-colored), its respective river network (blue-colored), the meteorological stations of “Likostomo” and “Vounochori”, Municipality of Kavala and “Eleftheroupoli”, Municipality of Paggaion, Prefecture of Kavala, etc. (thematic block symbol portraying a blue-colored cloud with rain), the settlements within that watershed (black-colored dots), the existing water-regulating dam nearby to the settlement of “Nikisiani”, Municipality of Paggaion and the existing “Simvoli” dam construction site (thematic block symbols portraying a retaining wall with water from one side in black color); (b) “Google Earth Explorer” map illustrating the specific studied dam catchment area (watershed) (green-colored perimeter continuous lines for both “Tenagi Plains Main Draining Ditch” and “Aggitis River” watersheds), its respective river network (white-colored) and the existing dam construction site (yellow-colored pin).

3. Materials and Methods

“Hydrologic Engineering Center—Hydrologic Modeling System” free software (abbreviated as “H.E.C.-H.M.S.”) produced by “United States Army Corps of Engineers” was brought into use to convert continuous total cumulative monthly rainfall time series into

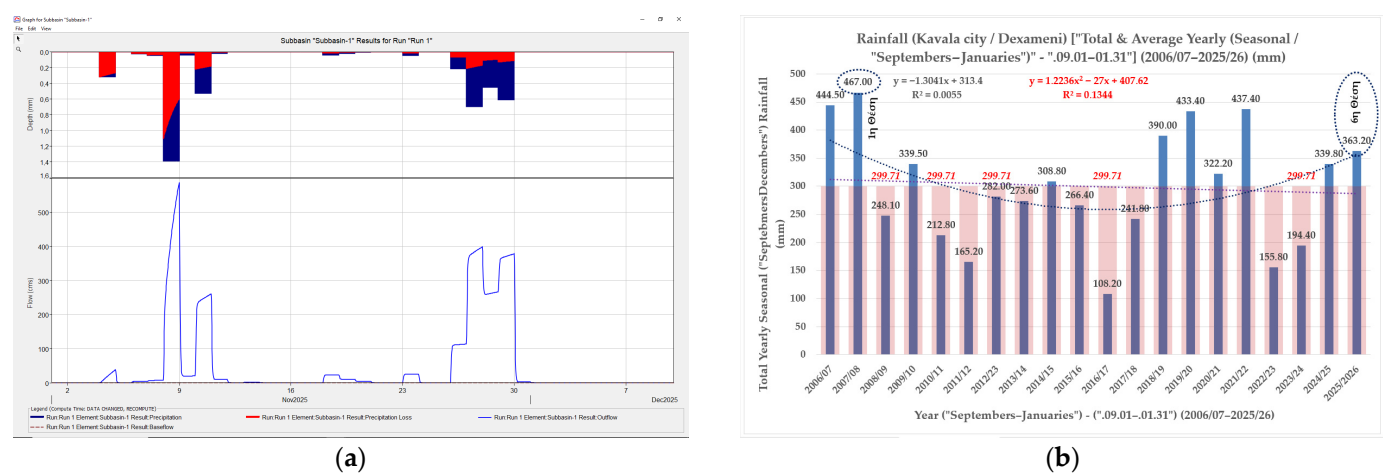


Figure 3. (a) Hydrograph and flood-graph resulting from HEC-HMS hydrological modeling software (concerning the “Simvoli” dam, November 2025, which produced a total monthly accumulated calculated stream flow or discharge of 168,076,000 m³ and a peak computed stream flow or discharge of 587.50 m³/sec), emerging due to the 215.80 mm of total monthly cumulative recorded rainfall, [“Likostomon” (installed, powered, managed and administrated by the personnel of “meteokav.gr”) meteorological station]; (b) “Thermometer”-type histogram chart depicting the last twenty (20) hydrological years’ first five months’ (from “September 2006–January 2007” up to “September 2025–January 2026) total accumulated recorded rainfall depth, (blue-colored bars) versus the total accumulated average rainfall depth, (red-colored bars, 299.71 mm), [“Kavala city/Dexameni settlement area” (installed, powered, managed and administrated by the personnel of “meteokav.gr”) meteorological station] [7,8].

4. Results

4.1. Quantitative Outcomes (Hydrological Year 2024–2025, September 2024–August 2025)

HEC-HMS hydrological modeling software computations yielded the following results pertinent to the specific studied dam (total cumulative water quantities concerning the hydrological year 2024–2025, (September 2024–August 2025) as well as dam percentage of fullness that would be achieved at the same time:

- “Simvoli” dam: (717.80 mm of rainfall), 376,304,600 m³;

The abovementioned values correspond to a total water yield of 94,211,700 m³ for the hydrological year 2024–2025 (September 2024–August 2025).

4.2. Visual Outcomes (Hydrological Year 2024–2025, September 2024–August 2025)

Below are the hydrograph and flood-graph resulting from “H.E.C.-H.M.S.” hydrological modeling software (concerning the “Simvoli” dam, December 2024), emerging due to the 201.80 mm of total monthly cumulative recorded rainfall, [“Likostomon” (installed, powered, managed and administrated by the personnel of “meteokav.gr”) meteorological station] [4–9], whereas the dam’s catchment area, hypothetical fullness and total discharge are depicted in Table 1.

Table 1. Brief listed report of the catchment area size (km²) and total stream flow (discharge) that might have been accumulated by each separate study of the specific studied dam studied during the hydrological year 2024–2025 (September 2024–August 2025).

Dam	Catchment Area (km ²)	Total Discharge (Hydrological Year 2024–2025) (m ³)
“Simvoli” dam	1364.95	376,304,600

Total water yield of 376,304,600 m³ for the hydrological year 2024–2025 (September 2024–August 2025).

4.3. Quantitative Outcomes (Hydrological Year 2025–2026, September 2025–January 2026)

HEC-HMS hydrological modeling software computations yielded the following results pertinent to the specific dam (total cumulative water quantities concerning the hydrological year 2025–2026 (September 2025–January 2026), as well as dam percentage of fullness that would be achieved at the same time:

- “Simvoli” dam: (657.00 mm of rainfall), 460,658,000 m³;

The abovementioned values correspond to a total water yield of 460,658,000 m³ for the hydrological year 2025–2026 (September 2025–January 2026).

4.4. Visual Outcomes (Hydrological Year 2025–2026, September 2025–January 2026)

Above are the hydrograph and flood-graph resulting from HEC-HMS hydrological modeling software (concerning the “Simvoli” dam, November 2025), emerging due to the 215.80 mm of total monthly cumulative recorded rainfall, [“Likostomon” (installed, powered, managed and administrated by the personnel of “meteokav.gr”) meteorological station] [4–9], whereas the dam’s catchment area, hypothetical fullness and total discharge are depicted in Table 2.

Table 2. Brief listed report of the catchment area size (km²) and total stream flow (discharge) that might have been accumulated by the “Simvoli” dam during the hydrological year 2025–2026 (September 2025–January 2026).

Dam	Catchment Area (km ²)	Total Discharge (Hydrological Year 2025–2026) (September 2025–January 2026) (m ³)
“Simvoli” dam	1364.95	460,658,000

Total water yield of 460,658,000 m³ for the hydrological year 2025–2026 (September 2025–January 2026).

5. Conclusions

On the one hand, a total water yield of 376,304,600 m³ for the hydrological year 2024–2025 (September 2024–August 2025) with a respective amount of rainfall reaching the height of 717.80 mm means it can be considered a relatively wet hydrological year by limiting the total recorded monthly accumulated rainfall analysis only to the first five months of each hydrological year, since the 2024–2025 value (339.80 mm) lies above the respective average (299.71 mm). On the other hand, a total water yield of 460,658,000 m³ for the hydrological year 2025–2026 (September 2025–January 2026) with an amount of rainfall reaching, so far, the height of 657.00 mm means it can be considered a relatively wet hydrological year by limiting the total recorded monthly accumulated rainfall analysis only to the first five months of each hydrological year, since the 2025–2026 value (657.00 mm) lies significantly above the respective average (299.71 mm). The above-mentioned values lead to the conclusion that during the first five months of the hydrological year 2025–2026 (September 2025–January 2026) the total recorded rainfall (657.00 mm) slightly lags behind the total recorded rainfall of the hydrological year 2024–2025 (September 2024–August 2025) (717.80 mm), whilst in comparison the respective total water yields were correspondingly 460,658,000 m³ [hydrological year 2025–2026 (September 2025–January 2026)] and 376,304,600 m³ [hydrological year 2024–2025 (September 2024–August 2025)]. Thus, there has been an increase in total accumulated stream flow or discharge (in m³) of 22.42% between two successive hydrological years, taking into consideration that the hydrological year 2025–2026 (September 2025–January 2026) has not been completed yet.

Taking into consideration that the underground water exploitation has almost reached, if not exceeded in many places and cases, its limits in providing the proper amounts of water to satisfy both irrigation and domestic water needs, it goes without saying that the

study and construction processes of flood protection and draining works (including all the other mandatory steps, e.g., bid and tendering preparations processes, etc.) should commence as soon as possible to avoid any further delay [4–9].

Several press articles [10–12] have been announced and official questions [13] have been submitted to the Hellenic Parliament by several different parliament parties, requesting answers pertinent to the actions of the Greek Government, which have either been or are scheduled to be taken in order to ensure that the technical works required to assist the area in coping with the flooding problems and equipping it with the necessary proper water draining systems will be finally realized.

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