Advances in Natural and Applied Sciences, 4(1): 33-38, 2010
ISSN 1995-0772
© 2010, American Eurasian Network for Scientific Information
This is a refereed journal and all articles are professionally screened and reviewed

# ORIGINAL ARTICLE

## Preparing the envelop curve of precipitation for Semnan province

**[1]Saleh Arekhi, [2]Ghobad Rostamizad, [3]Hojat Jalilian, [4]Noredin Rostami**

*[1]Professor Assisstant,Faculty of Natural Resources, Univ. of Ilam, Iran*
*[2]MSC. of watershed management, Faculty of Natural Resources, Univ. of Tehran, Karaj, Iran*
*[3]MSC. of watershed management, Faculty of Natural Resources, Univ. of Tehran, Karaj, Iran*
*[4]Ph.D. Candidate of watershed management, Faculty of Natural Resources, Univ. of Tehran, Karaj, Iran*

Saleh Arekhi, Ghobad Rostamizad, Hojat Jalilian, Noredin Rostami, Preparing the envelop curve of precipitation for Semnan province; *Adv. in Nat. Appl. Sci., 4(1): 33-38, 2010.*

**ABSTRACT**

Finding out The Probable Maximum Precipitation (P.M.P) and probable maximum flood are among the important issues of designing hydrologic structures. One of the most suitable techniques for predicting probable maximum precipitation is the envelop curve method. According to this method all records of precipitation are plotted in a log-log graph and finally a line which covers all events of precipitation is drawn. The results gained from such methods provide higher accuracy as well as reduces the cost of projects which is a very important issue in decision making.Accordingly envelop curve of precipitation was prepared in current research and the results showed that maximum 24-hour precipitation for Semnan province is 42 mm while the results for 48 hour, one month and one year data were 61, 135.2 and 344.2 mm respectively.

***Key words:*** Envelop curve, probable maximum precipitation, Semnan province.

### Introduction

Finding out the probable maximum precipitation and probable maximum flood are among the important issues of designing hydrologic structures. United States Geological Survey (1959) describes P.M.P as: the maximum hypothetical elevation of probable precipitation is an amount which is predicted by physical rules for a specific area in special period of a year. Probable expression emphasis that there is not any possibility of exact calculation for maximum precipitation because earth atmosphere physics has not been recognized clearly and climate data are very approximate. In other words, maximum elevation of precipitation in a basin for a specific time of rainfall and in a special period of year is called P.M.P. (Farokhzadeh, B., 1999). There are various methods for calculating P.M.P, one of which is the envelop curve method. In this method all records of precipitation for a location are plotted on a log-log graph in which X axis indicate time and Y axis is precipitation and finally a line is drawn in a way that covers all observed precipitation events. Designing hydrologic structures needs to survey and analysis of meteorology data and applying these analysis can have an important rule on success of these projects and increasing their useful life (Ghanbarpor, M.A., Telvary, 2003). For this reason use of envelop curve can help to reach to this goal. Rainfall in the form rain and snow are main sources of recharging surface and ground water. Direct measurement of precipitation by pluviometer, totalizer and pluviograph is done by ministry of energy and meteorological organization of country. In some cases research stations is establish by some organizations for their researches temporarily.

Hershfield (2005,1961) by use of general formula of rotation and records of daily rain for more than 2600 formal stations among which, %90 of are located in U.S.A. offered $PMP = \overline{P} + K.SD$ equation for calculation of P.M.P.

**Corresponding Author:** Ghobad Rostamizad, MSC. of watershed management, Faculty of Natural Resources, Univ. of Tehran, Karaj, Iran
E-mail: ghobadrostamizad@yahoo.com Tel.: + (09189409568)

where:

P.M.P= Probable Maximum Precipitation, $\overline{P}$ = mean observed of Precipitation, SD= standard deviation of observed Precipitation and K= rotation coefficient. He obtained amount of this coefficient for calculation of P.M.P to be equal to 15. Hershfield also collected the informal records of rainfall in 1981 that was evaluated by personnel of rain guage stations and by fitting envelop curve on them offered $P=422T^{0.475}$ equation for that envelop curve where: P= Precipitation(mm) and T= time(hour) (Konrad, C., 1995). Kapus *et al*. (1977) in a study in Halileh, near of Boshehr city, offered a graphical equation for evaluation of P.M.P and Precipitation events with 2 to 100 year return periods and 5min. to 24 hours time bases Konrad (1995) obtained the relation between precipitation, topography and local characteristics for a mountain in south of U.S. Rakhecha (1994) achieved to rainfall frequency zonation by use of hybrid guesser in Alabama. In recent decades, considering the importance of probable flood and its effects in designing dams weirs, a lot of efforts has been done for estimation of P.M.P. Tehran regional water organization with cooperation of Mahab Ghodss consulting engineering (1986) in multipurpose storage dam of Taleghan project attained to point evaluation of P.M.P in statistic and synoptic methods by use of rainfall records and evaporation of water surface. Mahab Ghodss consulting engineering (Jalilian, H., 2007) analysed P.M.P for Boshehr, Esfahan, Arak and Hamadan provinces by non-mountainous method and also evaluated P.M.P for stations of Arak, Hamadan(airport & nozheh) for a 24-hour period. Jalilian (2007) by use of rainfall records in north of Iran synoptic stations offered envelop curve for this location and also P=100.415T0.3647 equation was suggested for this location where: P= Precipitation(mm) and T= time(hour). Ghahraman and Sepaskhah (1994) attained to evaluation of P.M.P in some climate samples in south of Iran.

## Materials and methods

### *2.1. Case study*

Semnān is one of the 30 provinces of Iran. It is in the north of the country, and its center is Semnan. The province of Semnan covers an area of 96,816 square kilometers and stretches along the Alborz mountain range and borders to Dasht-e Kavir desert in its southern parts. Because of Semnan´s geography condition, its climate is desert, semi desert and arid, and because of soil and water limitation, agriculture status is not suitable. Citeis of the province include Semnan, Damghan, Shahrood and Garmsar.

### *2.2. Data source*

In this study records of all synoptic stations of Semnan province were used(3)(table 1). The records of 24-hour rainfall was entered into written programs with c++ and visual basic language for obtaining of max. rainfall amount in other time bases from 24 hour to 8784 hour(one year), next output of these program that was 8 records for max. rainfall in any time bases entered to excel software, then graph of these records drawn, as on this log-log graph X axis was time(hour) and Y axis was precipitation(mm), after that, a line that covered all of max. precipitation drawn. In this way for all of synoptic stations in Semnan an envelop curve obtained, finally by use of all of records envelop curve of precipitation of Semnan province offered.

**Table 1:** Synoptic stations of Semnan province

| No. | station | duration | Longitude (degree) | Latitude (degree) | Elevation (m) |
|---|---|---|---|---|---|
| 1 | Semnan | 1961-2005 | 53 33 | 35 35 | 1130.8 |
| 2 | Shahrod | 1961-2005 | 54 57 | 36 25 | 1345.3 |
| 3 | Damghan | 2000-2005 | 54 19 | 36 09 | 1154.5 |
| 4 | Garmsar | 1982-2005 | 52 16 | 35 12 | 825.2 |

### *2.3. Methodology*

When records of 24-hour precipitation were entered into the programs written in c++ and visual basic language, these programs by use of corresponded algorithms, of these numbers will calculate the max. precipitation of other time bases from 24 to 8784 hours. Then these records will be classified in descent way and for each time base 8 max. records is offered, after that these records are entered into excel software and envelop curve for every station is obtained, finally for Semnan province by use of records of synoptic stations, precipitation envelop curve is drawn in excel software(fig 1 to 5). Equations of these curves for synoptic stations of Semnan province are as followed (equations 1 to 5).

| | |
|---|---|
| Semnan province:(equation1) | P=13.53t0.3564 |
| Semnan city:(equation2) | P=14.54t0.326 |
| Garmsar city:(equation3) | P=15.244t0.2874 |
| Shahrod city:(equation4) | P=13.53t0.3564 |
| Damghan city:(equation5) | P =8.845t0.326 |

Where: P= Precipitation(mm) and T= time(hour) correlation coeficient of all of these equations is more than %90 and level of significance of these equations is %1.

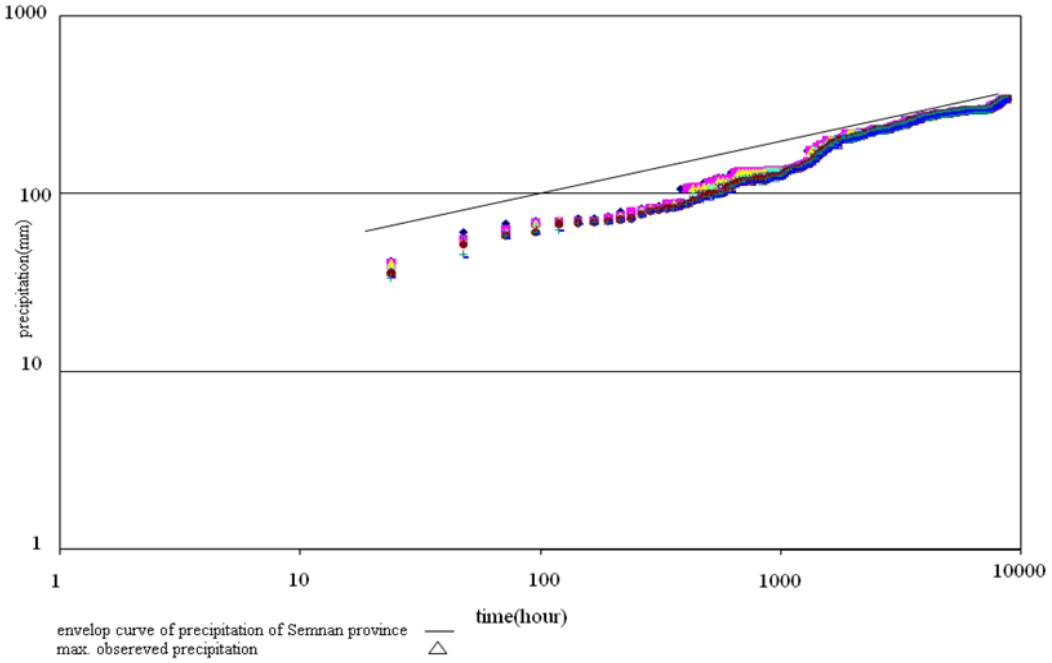


**Fig. 1:** Envelop curve of precipitation of Semnan province

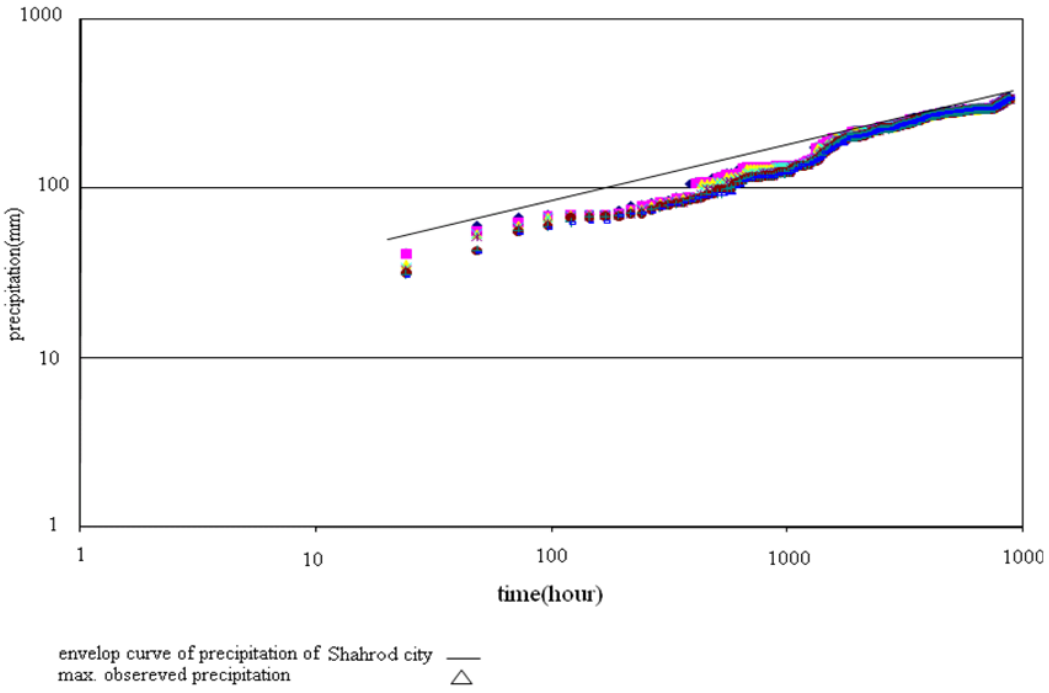


**Fig. 2:** Envelop curve of precipitation of Shahrod city

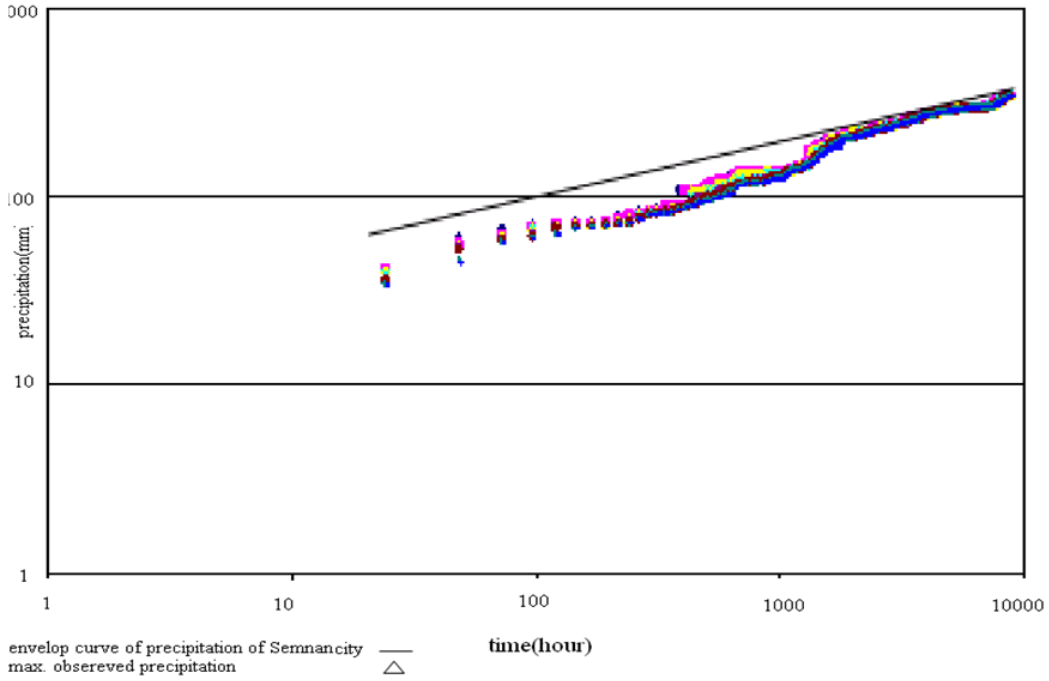


**Fig. 3:** envelop curve of precipitation of Semnan city

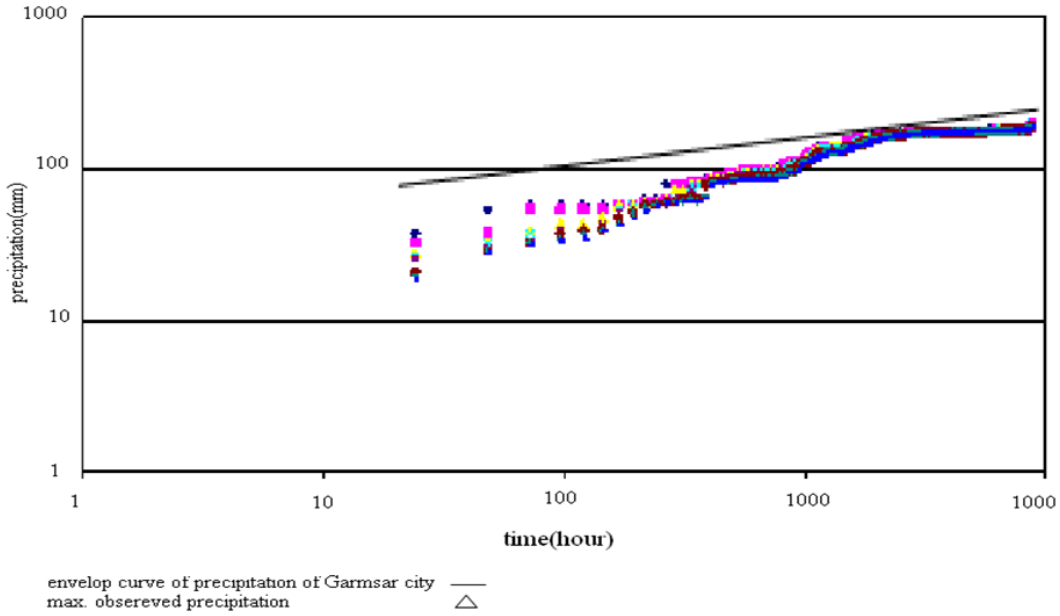


**Fig. 4:** Envelop curve of precipitation of Garmsar city

## Results and discussion

Because in envelop curve method all records are used and are easily and fast applicable by using computer softwares, it can be applied for designing hydraulic structures, in other hand the records of max. Precipitation that are obtain by P.M.P method may never happen but the records that are obtain in this method are records has happened in the past, therefore, can be used for determining P.M.P with more confidence.

Comparison of max. observed Precipitation of Semnan province and max. observed Precipitation of the world clearly shows that Precipitation of Semnan is too less than max. observed Precipitation in the world and this difference in long time Precipitation is obvious Clearly, however short time Precipitations amount is less than world max. too, in a way that max. observed Precipitation of Semnan province is between %1 to %3 of

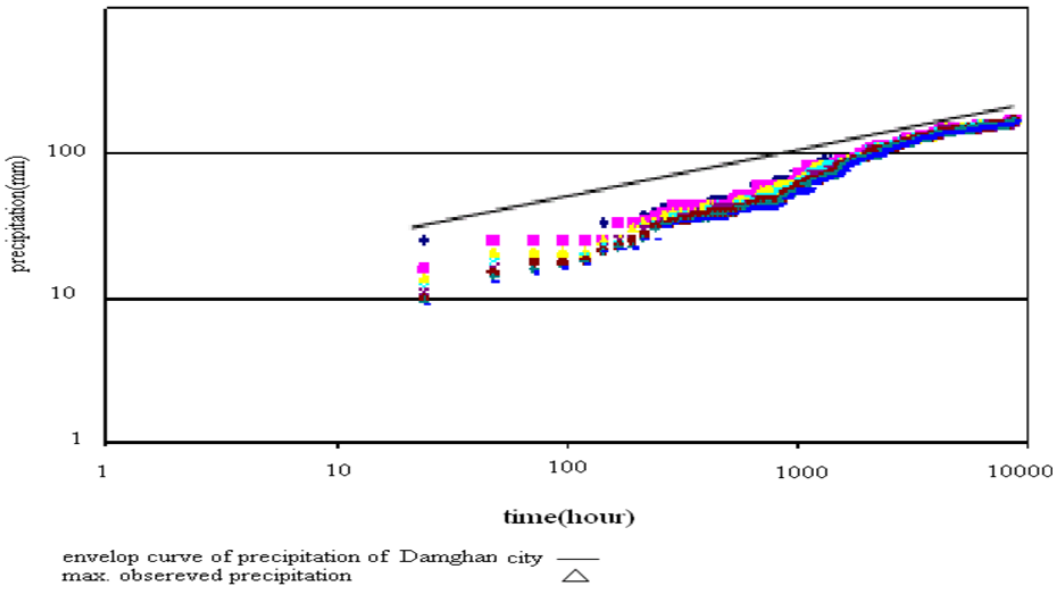


**Fig. 5:** Envelop curve of precipitation of Damghan city

max. observed Precipitation in the world (table 4). This condition is because of special climate and geology status of this province and its location in mid latitude and its distance from the sea. In tables 2 and 3 the max. observed precipitation of the world and Semnan are represented respectively and in table 4 records of table 2 and 3 are compared with each other. Because of lack of short time and showery Precipitation records, envelop curve for time bases of less than 24 hours has not been evaluated but by use of equations 1 to 4 these records can be evaluated for various cities of Semnan province. For Semnan province the max. evaluated precipitation for 60, 20 and 15 minutes is equal to 13.53, 9.14 and 8.25 mm respectively (table2).

**Table 2:** Max. observed rains in various time bases in the world

| location | Precipitation(mm) | time |
|---|---|---|
| Bavaria(Germany) | 126 | 8 min. |
| plumb point(Jamaica) | 198 | 15 min. |
| Missouri(America) | 305 | 42 min. |
| Shanghai(China) | 401 | 1hour |
| Modeo chaidung(China) | 840 | 6 hour |
| Reunion islands | 2467 | 2day |
| Cherrapunji (India) | 5003 | 7 day |
| Cherrapunji (India) | 9300 | 1month |
| Cherrapunji (India) | 22454 | 6month |
| Cherrapunji (India) | 26461 | 1 year |

**Table 3:** Max. observed rains in various time bases in Semnan province

| location | Precipitation(mm) | time |
|---|---|---|
| Shahrod city | 42 | 24 hour |
| Shahrod city | 61 | 48 hour |
| Shahrod city | 68.2 | 72hour |
| Semnan city | 73 | 7 day |
| Semnan city | 258 | 1 month |
| Shahrod city | 283.2 | 6 month |
| Shahrod city | 344.2 | 1 year |

**Table 4:** Comparison of max. observed rains in Semnan province and the world

| time | max. observed rains in Semnan province(mm) | max. observed rains in the world(mm) | Ratio of max. observed rains in Semnan province to max. observed rains in the world (%) |
|---|---|---|---|
| 2day | 61 | 2467 | 2.5 |
| 7day | 73 | 5003 | 1.5 |
| 1month | 258 | 9300 | 2.78 |
| 6month | 283.2 | 22454 | 1.26 |
| 1 year | 344.2 | 26461 | 1.3 |

Comparison of max. observed Precipitation of synoptic stations of Semnan province with each other also show that max. observed Precipitation in Shahrod city is more than other cities and in Semnan is more than Garmsar and Damghan.

**References**

Farokhzadeh, B., 1999. Evaluation of max. precipitation in various time sections and their relations in some sample climates of Iran. Thesis of master of science, Faculty of Natural Resources, Univ. of Tehran.

Ghanbarpor, M.A., Telvary, 2003. Rainfall temporal pattern of synoptic stations in north of Iran. Pagouhesh va sazandegi in natural resources journal, 59: 96-103.

Ghahraman, B.A., Sepaskhah, 1994. Determining of extreme values in south of Iran. Nivar review, scientific and technical journal of meteorological organization, 22: 24-37.

Hershfield, D.M., 1961. Estimating the Probable Maximum Precipitation. J. Hyd. Div., Am. Soc. of Civil Eng., 87: Hy. 99-116.

Hershfield, D.M., 1981. The magnitude of the hydrological frequency factor in maximum rainfall estimation.Hydro.Sci.Bulletin, 26(2-6): 171-177.

Jalilian, H., 2007. Preparing the envelop curve of precipitation for Northern Iran. MSC. seminar, Faculty of Natural Resources, Univ. of Tehran, pp: 80.

Konrad, C., 1995. Maximum precipitation rates in the southern Blue Ridge mountains of the southeastern United States. Climate Research, 5: 159-166.

Kapus, U.J., M., Bleek and S.H. Blair, 1977. Rainfall frequencies for the Persian Gulf coast of Iran. Hydrological Sciences-Bulletin-des Sciences Hydrologiques, 23: 1-3/1978.

Meteorological organization of Iran, 2007. Precipitation records of Semnan province.

Mahdavi, M., 2005. Applied hydrology. Tehran university press., 1: 401.

Rakhecha, P.R., Mandal and Bn Kulkarni, 1994. estimation of probable maximum precipitation for catchment in eastern by a generalized method .Theor. Appl. Climatol 1995, 51: 67-74.

Tehran regional water organization & cooperation of Mahab Ghodss consulting engineering, 1986. Report of multipurpose storage dam of Taleghan project.

Tehran regional water organization & cooperation of Mahab Ghodss consulting engineering, 1987. Evaluation of P.M.P for 15 Khordad dam project.