Using Neural Network Models to Forecast the Inflow of Doroudzan Dam – Iran

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Iran with an average annual rainfall of 230 mm is in the categories of semi-arid countries. Using water and optimizing exploitation of water sources has always been considered. Therefore many dams are built to control water in Iran. One of the most important dams in the south of Iran, in Fars province, is Doroudzan dam which has an important role as the water provider for the biggest center of wheat production in Iran. Scheduling to have optimum water exploitation of this resource necessitates realistic forecasting of inflow to the dam reservoir. One of the methods to forecast inflow to the reservoirs is to use neural network models which are considered in this paper. In this study Qnet 2000 computer model is used and its results are presented for practical applications.

Doroudzan dam

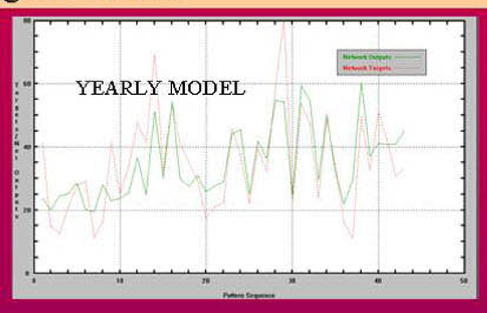
The multipurpose earth fill Doroodzan dam is located some 85 km. North West of Shiraz on Kor River and in the Bakhtegan lake catchment area. Droodzan dam studies and investigation were carried out in the years 1963 to 1966 and the dam construction were started in 1970 and was complicated in 1974. The consulting engineer was Justin & Courtney jointed with Taleghani & Daftari. The contractor was WRD.

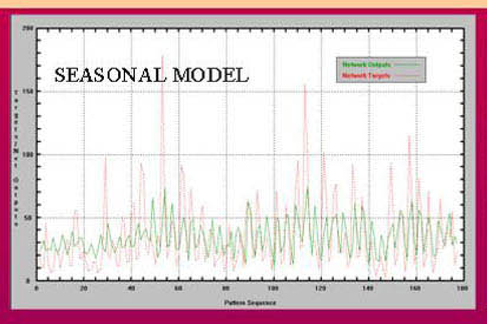
The objectives of constructing Doroodzan dam are as follows:
Irrigation water supply for 110/000 ha.
Supplying parts of urban water needs for the cities of Marvdasht and Shiraz.
Supplying industrial water needs of the nearby factories.
Flood control of Kor river.
Energy generation.

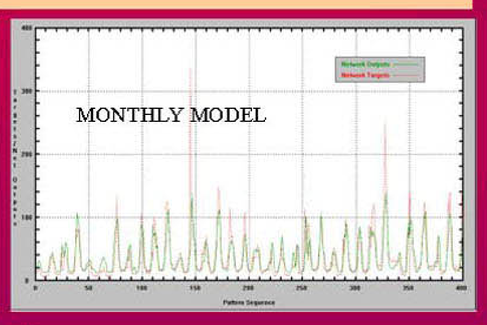
The importance of forecasting inflow to Doroudzan dam

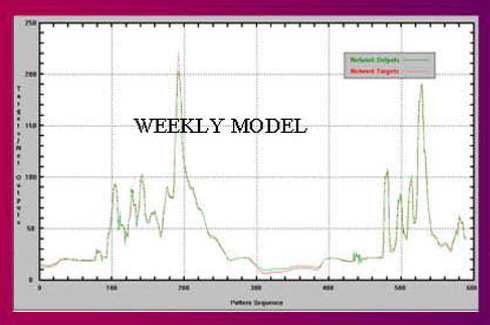
Forecasting inflow to doroudzan dam has always been one of the main programs of water resource managers of this dam and can be considered in some aspects:
Planning for exploitation of water resources in future
Planning for the years with water shortage (preventing drought)
Planning to save water in excess of use and change it to energy in wet years.
Planning to determine consumption patterns and generating energy

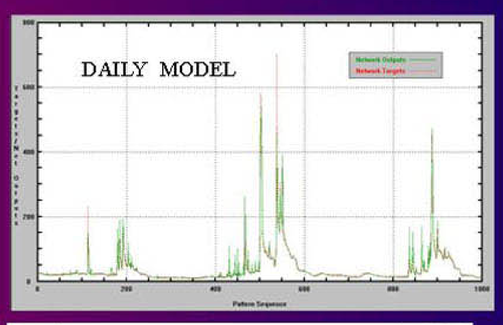
Using the mentioned data, different combinations of neural network models were prepared Using the mentioned data, different combinations of neural network models were prepared. Tables 1 to 5 shows combination of different parameters which are used in each model for daily, weekly, monthly, seasonal and annual forecasting. Considering amounts of data, 80% of data was used for training the model and 20% for testing the model. Evaluating the models, with parameter combination as mentioned in table 6, selected models were recognized. Correlation results of best models, in each case of training model is presented in figure below.











number models	Parameters which are used in yearly models					RESULT train	RESULT test
43	q-1	p-1	p-2	p-3		79	77
44	q-1	p-1	p-2			78	76
45	q-1	p-1				35	33
46	q-1					30	27
47	q-1	p-1	p-2		soi	79	77
48	q-1	p-1	p-2	0	soi	78	76

q-1: inflow with 1 year delay,
p-1:yearly rainfall with 1 year dlay,p-2 yearly rainfall with 2 year dlay, ...,
soi Southern Oscillation Index elnino parameter

number models	Parameters which are used in monthly models					RESULT train	RESULT test
31	q-1	p-1	p-2	p-3		73	71
32	q-1	p-1	p-2			70	68
33	q-1	p-1				65	63
34	q-1					60	55
35	q-1	p-1	p-2		soi	71	69
36	q-1	p-1	p-2	0	soi	66	64

q-1: inflow with 1 month delay,
p-1: monthly rainfall with 1 month dlay,p-2 monthly rainfall with 2 month dlay, ...,
soi Southern Oscillation Index elnino parameter

number models	Parameters which are used in seasonaly models					RESULT train	RESULT test
37	q-1	p-1	p-2	p-3		54	52
38	q-1	p-1	p-2			45	43
39	q-1	p-1				38	35
40	q-1					30	27
41	q-1	p-1	p-2		soi	60	56
42	q-1	p-1	p-2	p-3	soi	55	52

q-1: inflow with 1 season delay,
p-1:seasonaly rainfall with 1 month dlay,p-2 seasonaly rainfall with 2 month dlay, ...,
soi Southern Oscillation Index elnino parameter

number models	Parameters which are used in weekly models								RESULT train	RESULT test
23	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2	95	92.5
24	q-1	q-2	q-3	q-4	q-5	q-6	p-1		94	91
25	q-1	q-2	q-3	q-4	q-5		p-1	p-2	93	90
26	q-1	q-2	q-3	q-4			p-1	p-2	94	92
27	q-1	q-2	q-3	q-4	q-5		p-1		93	91
28	q-1	q-2	q-3	q-4			p-1		92	90.5
29	q-1	q-2	q-3				p-1	p-2	91	88
30	q-1	q-2	q-3				p-1		89	87

q-1: inflow with 1 day delay,q-2 inflow with 2 day delay, q3 inflow with 3 dayes delay....
p-1:weekly rainfall with 1 week dlay,p-2 weekly rainfall with 2 week dlay, ...,

number models	Parameters which are used in daily models												RESULT train	RESULT test
1	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2	p-3	p-4	p-5	p-6	weekly	93%	91.5
2	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2	p-3	p-4	p-5		weekly	92	90
3	q-1	q-2	q-3	q-4	q-5		p-1	p-2	p-3	p-4	p-5	p-6	weekly	92	89.5
4	q-1	q-2	q-3	q-4			p-1	p-2	p-3	p-4	p-5		weekly	91	89
5	q-1	q-2	q-3	q-4	q-5		p-1	p-2	p-3	p-4			weekly	91	89
6	q-1	q-2	q-3	q-4			p-1	p-2	p-3	p-5			weekly	90	88
7	q-1	q-2	q-3				p-1	p-2	p-3				weekly	91	88
8	q-1	q-2					p-1	p-2					weekly	93	89
9	q-1						p-1	p-2					weekly	91	88
10	q-1						p-1						weekly	90	88
11	q-1												weekly	87	83
12	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2	p-3	p-4	p-5	p-6		91%	89%
13	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2	p-3	p-4	p-5			90	88%
14	q-1	q-2	q-3	q-4	q-5		p-1	p-2	p-3	p-4	p-5	p-6		89	86.5
15	q-1	q-2	q-3	q-4			p-1	p-2	p-3	p-4	p-5			88	85
16	q-1	q-2	q-3	q-4	q-5		p-1	p-2	p-3	p-4				88	85
17	q-1	q-2	q-3	q-4			p-1	p-2	p-3	p-5				89	86
18	q-1	q-2	q-3				p-1	p-2	p-3					88	84
19	q-1	q-2					p-1	p-2						85	83
20	q-1						p-1	p-2						86	84
21	q-1						p-1							87	85
22	q-1													85%	80%

q-1: inflow with 1 day delay,q-2 inflow with 2 day delay, q3 inflow with 3 dates delay,....
p-1: daily rainfall with 1 day dlay,p-2 idaily rainfall with 1 day dlay, ..., weekly result model
weekly : weekly result of best model

As it was discussed, due to exploitation of Doroudzan dam reservoir, forecasting the inflow can help flood control, generating energy and determining optimized subculture area so to forecast the inflow to Doroudzan dam using neural network model some neural network models was provided. Creating different models *Qnet* software was used and forecasting annual, monthly, weekly and daily inflow 8, 8, 15 and 14 neural network models respectively were used. Some data like daily, weekly, monthly, seasonal and annual inflow to reservoir, rainfall and the data related to elnino were used in these models. The models were prepared with the combination of mentioned parameters and different time delays_by *Qnet* software. Finally some models had better results beside the others which can be presented models no. ۱, ۲۳, ۳۱, ۴۱ and ۴۳ as chosen model to forecast daily, weekly, monthly, seasonal and annual inflow respectively. As it is seen, the best adaptation is related to weekly inflow models, which can help the energy generation program. Monthly and seasonal models regardless of less correlation beside weekly models can be used to plan energy generation from January to April and can be used to determined subculture area.

number models	BEST MODELES IN EACH CASE												RESULT train	RESULT test
1	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2	p-3	p-4	p-5	p-6	daily	93%	91.5
23	q-1	q-2	q-3	q-4	q-5	q-6	p-1	p-2					weekly	95%	92.5
31	q-1						p-1	p-2	p-3				monthly	73%	71
41	q-1						p-1	p-2				soi-1	seasonl	60%	56
47	q-1						p-1	p-2	0			soi-1	yearly	79%	77