JYP

AGRICULTURAL ENGINEERING

WaBcal - A Calculator for Preparing Water Budget of Discrete Land Unit

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ABSTRACT

WaBcal is a calculator to prepare water budget of any discrete land unit. It is developed in C language and follows water budget norms proposed by National Agriculture Commission (1972,2002). Major input to the model is normal rainfall of that area and this is proportionately equated into surface flow, ground water flow, evaporation at various stages and magnitude, soil moisture etc. The calculator considers different water needs of the area which include demand from agriculture, domestic, livestock and industries. Total 27 field crop, nine vegetables and six fruit crop and six other crops are prevailing in Madhya Pradesh that may be used for computing agriculture demand. 18 Animals are considered for live stalk demand. Population gives domestic water demand. As an output the calculator gives water surplus/deficit of the study area.

Highlights

◉ Wabcal software calculator has been developed in C language for preparing the water budget
◉ By knowing the normal rainfall and water demand of different sectors including domestic and agriculture, this software tool computes the various water budget components like surface flow, evaporation, total surface flow, ground water availability, surplus and deficit of water etc. for any discrete land unit.

Keywords: WaBcal, water budget, water needs, water surplus, water deficit

Water budget of an area helps in understanding water potential and its current use/loss. Once the available quantum is known its optimal allocation for different purposes can maximize gain from that area. Healy *et al.* (2007) illustrate importance of having water budget of any basin in hand for planning agricultural, cultural, environmental and social planning. (Kumar 2012) pointed out that water balance techniques have been extensively used to make quantitative estimates of water resources. The GW availability of an area can also be assessed with water fluctuation method. Khare *et al.* (2006) assessed surface and ground water resources availability for irrigation in Sapon irrigation command. Indonesia. Water resource assessment at basin level using water balance approach and remote sensing has also in practice with proper hydrological model selection and its parameterization (Shriadhionkar 2015). Water balance may also be used for estimation of Evapotranspiration (Jain 2012), ground water potential of basin (Maurya, 2017) and evaluation of different catchment modules Dhage *et al.* (2014). A study of demand and supply of water in India was analyzed by (Bhatt 2014). He postulated reasons for increasing demand of water as population growth, growing urbanization and agriculture etc.

A programme, WaBcal (*~webkel*), has been developed and presented in this paper written in C, for calculating water available for utilization and also for computing water needs from different sectors.

MATERIALS AND METHODS

National Commission on Agriculture (NCA, 1972, 2002) has suggested different components of water budget and their partial magnitude. Like other water budgeting it also has major/sole input of rainfall when falls over an area, which is much as a discrete unit, generates total volume of available water. Its distribution, as per NCA, into Immediate evaporation (17.5%), Surface flow (28.7%), From outside state(10.549% of total surface flow), To GW from flood flows (-4.851% of total surface flow), From GW to surface flow (23.739% of total surface flow), From irrigated area to surface flow (7.067% of total surface flow), Total surface flow(45.198% of total ppt), Evaporation lossess from reservoirs and tanks (7.916% of total surface flow), Flow into seas and outside state (43.445% of total surface flow), Utilizable surface flow (48.639% of total surface flow), Water available for ground water storage (12.5%), From streams and flood flows to GW (4.851% of total surface flow), From irrigation to GW addition (S.N.14-(11+12)), Total GW (21.492% of total ppt), Evaporation and rise of water table (18.451% of total GW), Regeneration into streams (49.924% of total GW), GW available utilization (31.625% of total GW), Total utilizable surface + GW (S.N. 10+17), Soil moisture storage (41.3% of normal rainfall), From irrigated area to soil moisture (7.067% of total surface flow), Total soil moisture storage (44.495% of total ppt), Evaporation lossess from soil moisture (31.504% of total soil moisture storage), Evap. lossess from forest and other veg. (30.826% of total soil moisture), Soil moisture available for ET from crops (37.673% of total soil moisture)and Water available for utilization (S.N. 18+24).

The demand arises from agriculture sector, domestic needs, livestalk and from industries. The total demand when subtracted from the water available for utilization results into water surplus/deficit situation. Awasthi *et al.* (2017) prepared water budget of all districts of Madhya Pradesh and have been a basis of verifying results obtained from WaBcal.

Water needs from different crops may be computed through following procedure.

(i) *Crop water need* - 27 field crops namely; Rice, Jowar, Bajra, Maize, Ragi, Wheat, Barley, Millets, Gram, Arhar, Sugarcane, Groundnut, Castor seed, Sesamum, Rapeseed and Mustard, Linseed, Soyabean, Niger seed, Sunflower, Safflower, Other Oilseeds, Cotton, Jute, Mesta, Sanhemp, 9vegetables namely;Potato Sweet Potato Onion Other Vegetables Chillies and Ginger etc., six fruit crops namely; Mango, Banana, Citrus Fruits, Grapes Papaya and Other Fruits.

Total crop water need = $\sum W_i A_i$

W_i is water requirement of ith crop grown in A_i area

(ii) *Domestic water need* – It is a product of population (census 2011) and prescribed daily water need (135 lpd/person).

(iii) *Live stock water need* – Water needs for 18 animals namely; Cross breed Cattle (150 l/day), Indigenous Cattle (100 l/day), Bovine (150 l/ day), Sheep (10 l/day), Goat (10 l/day), Horse and Ponies (32.5 l/day), Mules (32.5 l/day), Buffalo (150 l/day), Donkey (32.5 l day) and Camels (115 l/day) etc.

Total water needs of all live stalk is computed as = $\sum L_i N_i$

Where, L_i and N_i are respectively water need and numbers of ith animal

(iv) *Industrial need* – Irrespective of the intensity of industrialization, the allocation towards this sector may be taken as six percent of available fresh water.

The flow diagram representing the process for water budgeting is given in Fig. 1.

RESULTS AND DISCUSSION

Programme development

The program WaBcal is designed in 'c' programming language that needs following INPUTS to assess the water budget of any discrete land unit selected for study.

- Normal rainfall of study unit, m

- Geographical area study unit, ha

- Water requirements for crops, ha m

- Water requirements for animal husbandry, ha m

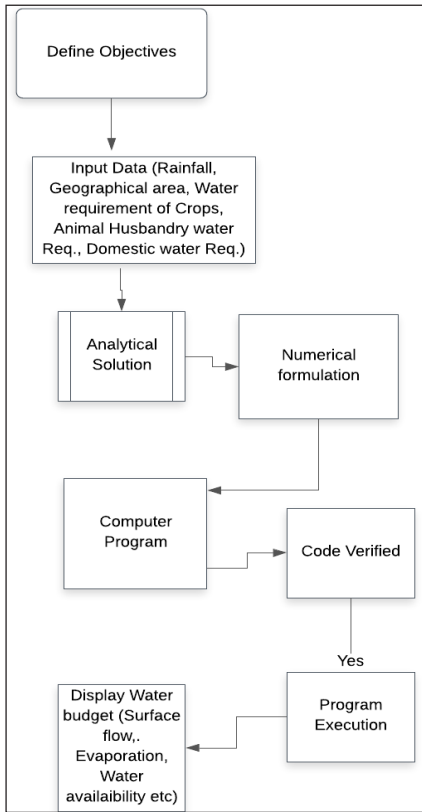- Water required for domestic requirements. ha m

Fig. 1: Flow Chart for WaBcal: Water Budgeting software tool

After successful execution of program, the resultant of the program received the following OUTPUTS, all in ha m

- Immediate evaporation,
- Surface flow,
- Total surface flow,
- Evaporation losses from reservoirs and tanks,
- Utilizable surface flow,
- Water available for ground water,
- Total ground water,
- Ground Water available utilization,
- Total utilizable surface + Ground water,
- Soil moisture storage,
- Evaporation losses from soil moisture,
- Evaporation losses from forest and other vegetation,
- Soil moisture available for Evapotranspiration from crops,
- Water available for utilization,
- Water required for different sectors,
- Surplus or deficit of water in the district.

SOURCE CODE: The source code of WaBcal program developed in this study is given as following, which will compute all the output parameters as discussed above for the provided inputs.

```c
#include<stdio.h>
int main()
{float rf,nrl_rf,evap,tot_surf_flow,surf_flow,geo_area,tot_ppt,wrc,wrah,dwr;
printf("Enter Rainfall \t");
scanf("%f",&rf);
printf("\nEnter Geographical Area \t");
scanf("%f",&geo_area);
printf("\nWater Requirment for Crops \t");
scanf("%f",&wrc);
printf("\nWater Required of Animal Husbandry \t");
scanf("%f",&wrah);
printf("\nDomestic Water Required \t");
scanf("%f",&dwr);
nrl_rf=rf*geo_area;
evap= 0.175*nrl_rf;
tot_ppt=nrl_rf;
tot_surf_flow=0.45198*tot_ppt;
surf_flow=nrl_rf*0.287;
float out_state=0.10549*tot_surf_flow;
float grd_to_flflow= -0.04851*tot_surf_flow;
float grd_to_surf_flow= 0.23739*tot_surf_flow;
float irri_to_surf_flow= 0.07067*tot_surf_flow;
float evap_from_tanks_reserv=0.7916*tot_surf_flow;
float flow_sea_out_state=0.43445*tot_surf_flow;
float util_surf_flow=0.48639*tot_surf_flow;
float flood_stream_grd=0.04851*tot_surf_flow;
float aval_grd_wt=0.125*nrl_rf;
float tot_grd_wt=0.21492*tot_ppt;
float irri_to_grd=tot_grd_wt-(aval_grd_
```

```
wt+flood_stream_grd);
float evap_rise_wt=0.18451*tot_grd_wt;
float regen_into_stream=0.49924*tot_grd_wt;
float util_aval_grd_wt=0.31625*tot_grd_wt;
float sgw=util_aval_grd_wt+util_surf_flow;
float soil_moist=0.413*nrl_rf;
float irri_to_soil_moist=0.07067*tot_surf_
flow;
float tot_soil_moist_str=0.44495*tot_ppt;
float evap_soil_moist=0.31504*tot_soil_
moist_str;
float evap_forest_otherveg=0.30826*tot_soil_
moist_str;
float soil_moist_for_et=0.37673*tot_soil_
moist_str;
float indus_wt_req=0.06*nrl_rf;
float aval_wt_util=sgw+soil_moist_for_et;
float wt_req_sects=wrc+wrah+dwr+indus_
wt_req;
float surf_wt_in_dist=aval_wt_util-wt_req_
sects;
printf("\n");
printf("\n\n\n\n\nEntered Normal
Railfall \t %f",nrl_rf);
printf("\nEntered Geographical Area \t
%f",geo_area);
printf("\nEntered Water Required for Crops
\t %f",wrc);
printf("\nEntered Water required for
Animal Husbadry \t %f",wrah);
printf("\nEnterd Domestic Water Required
\t %f",dwr);
printf("\nNormal Railfall, ha m \t %f",nrl_
rf);
printf("\nImmediate Evaporation \t
%f",evap);
printf("\nSurface Flow \t %f",surf_flow);
printf("\nFrom Outside State \t %f",out_
state);
printf("\nTo GW from flood flow \t
%f",grd_to_flflow);
printf("\nFrom GW to surface flow \t
```

```
%f",grd_to_surf_flow);
printf("\nFrom irrigated area to surface
flow \t %f",irri_to_surf_flow);
printf("\nTotal surface flow \t %f",tot_
surf_flow);
printf("\nEvaporation losses from reservoirs
and tanks \t %f",evap_from_tanks_reserv);
printf("\nFlow into seas and outside states
\t %f",flow_sea_out_state);
printf("\nUtilizable surface flow \t %f",util_
surf_flow);
printf("\nWater avaliable for ground water
storage \t %f",aval_grd_wt);
printf("\nFrom streams and flood flows to
ground water \t %f",flood_stream_grd);
printf("\nFrom irrigation to ground water
\t %f",irri_to_grd);
printf("\nTotal ground water \t %f",tot_
grd_wt);
printf("\nEvaporation and rise of water
table \t %f",evap_rise_wt);
printf("\nRegeneration into streams \t
%f",regen_into_stream);
printf("\nGround water avaliable utilization
\t %f",util_aval_grd_wt);
printf("\nTotal utilizable surface + Ground
water\t %f",sgw);
printf("\nSoil Moisture Storage \t %f",soil_
moist);
printf("\nFrom irrigated area to soil
moisture \t %f",irri_to_soil_moist);
printf("\nTotal soil moisture storage \t
%f",tot_soil_moist_str);
printf("\nEvaporation lossess from soil
moisture \t %f",evap_soil_moist);
printf("\nEvaporation lossess from forest
and other vegetation \t %f",evap_forest_
otherveg);
printf("\nSoil moisture avaliable for ET and
crops \t %f",soil_moist_for_et);
printf("\nWater Requirment for Crops
\t",wrc);
printf("\nWater Required of Animal
```

Husbandry \t",wrah);

printf("\n Domestic Water Required \t",dwr);

printf("\nIndustrial Water Requirments \t %f",indus_wt_req);

printf("\nWater avaliable for utilization \t %f",aval_wt_util);

printf("\nWater Required for different sectors \t %f",wt_req_sects);

printf("\nSurplus or deficit of water in the district \t %f",surf_wt_in_dist);

return 0;

}

CONCLUSION

WaBcal which is a calculator for different components of water budget is prepared in C-language. By knowing water demand of different sectors including domestic and agriculture, the water budget can be computed on the basis of known normal rainfall and geographical area. It calculates components like surface water, ground water, evaporation and utilizable water quantity. The WaBcal also calculates Water surplus and deficit of an area.

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