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RESEARCH PAPER

Design of cost effective rainwater harvesting systems through computer 'C' programme

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ABSTRACT

An investigation was carried out to calculate water budgeting and to design cost effective rain water harvesting systems through computer C programme. To calculate water budget at residential buildings and for designing the different components involved in the rooftop rainwater harvesting structure, a computer programming was developed in C language for both slopy terrace (residential blocks) and flat terraces (hostel buildings) and the C programme was developed for the calculation of water budgeting in different buildings to find out the total demand, total supply and total deficit or surplus water after the installation of the structure for residential blocks and hostel buildings in Tamil Nadu Agricultural University, Campus. Coimbatore.

Key Words : Rainwater harvesting, Computer C programme, Rooftop rainwater harvesting, Cost analysis

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Water is considered as liquid gold of our life. Every living cell is water dependent and water sustained. All human activities are predicted upon the availability of water. Water is omnipresent; its existence is a fundamental assumption. Water is considered to be a free commodity-a substance to be taken, used and disposed-without a thought that it is becoming valuable. Agriculture has always remained a gamble with monsoon, and the situation is further assuming precarious levels due to non-adherence of implementing water harvesting strategies. The term 'water harvesting' is the art and science of improving water yield efficiency of a catchment and utilization of the surface runoff in a smaller collection or spreading area by direct cultivation of plants or through storage and recycling (Bali, 1988). However, this concept is an 'old wine in a new bottle'. It is very much needed in the recent years, to narrow down the supply-demand gaps of water. If 5 per cent of annual rainfall is harvested properly, that would produce a substantial quantum of water to the tune of 900 million litres.

RESEARCH METHODOLOGY

Study was carried out to calculate water budgeting and to design cost effective rain water harvesting systems through computer C programe for residential premises and hostel building based on rainfall analysis, at Tamil Nadu Agricultural University, Campus in Coimbatore.

Experimental site:

For designing roof top rainwater harvesting structures,

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residential buildings 'B' C' and 'D' type , P.G Hostel, P.P.C Hostel and Tamizhagam Hostel were selected and the area was located in the southern side of the TNAU campus. The TNAU campus was located at latitude of 11° N, longitude of 77 °E and altitude of 426.72 m (above MSL). The average annual rainfall of TNAU campus was 677.8 mm (35 years average).

Description of the study area :

To provide rainwater harvesting structures some houses of 'B', 'C' and 'D' type residential blocks. P.G, P.P.C and Tamizagam hostels were selected. The residential blocks were located just beside of P.G hostel building. All these buildings have same structural framework which is in the form of gabled type, provided with Mangalore tiled roof with a slope of 35° and the P.G hostel was a three storied building with flat terrace roof surface. The water to this hostel is being supplied from a circular overhead tank which is situated at the backside of the P.P.C hostel. The water is being pumped from a tube well located at the backside of the Tamizhagam hostel. The P.P.C hostel was consisted of a two storied building, which has a flat terrace roof but Tamizhagam hostel was consisted of a three storied building, which has flat terrace roof.

Water budgeting studies:

For the water budgeting analysis, the individual buildings of P.G hostel, P.P.C hostel, Tamizhagam hostel and residential blocks of 'B' 'C' 'D' type were selected and the weekly demand and supplies for these buildings were arrived at during the study period.

Therefore, the C programmes were developed for water budget calculation and design of rooftop rainwater harvesting structure for residential and hostel buildings

RESULTS AND REMONSTRATION

The results of the present study as well as relevant discussion have been summarized under following heads:

Development of C programmes:

It is felt that calculation of different design specifications for rooftop water harvesting system is time consuming and labourious. It will be convenient to estimate the specifications and design components, if we develop computer programme. Therefore the C programmes were developed for water budget calculation and design of rooftop rainwater harvesting structure for residential and hostel buildings. The scripts for C programes are given in the sections 1.1 through 1.3.

'C' programme for water budget calculation:

```
#include <math.h>
#include <stdio.h>
void main()
{
    long stdweek,drinkw[100],cookw[100],person;
    long bathw[100],washh[100],houses[100],misc[100],
totalreq[100];
    long totalhar[100],estate[100],totalsupply[100],deficit
[100],surplus[100];
    double rainfall[100],erainfall[100],rupeessaved[100];
    long n,i,temp,totald=0,totals=0,roofarea;
    long sumtotalreq=0,sumtotalsupply=0;
    int temp1;
    clrscr();
    printf("water budget calculation \n");
    printf("how many weeks:\n");
    scanf("%ld",&stdweek);
    n=stdweek;
    for(i=1;i<=n;i++)
    {
    drinkw[i]=0;
    cookw[i]=0;
    bathw[i]=0;
    washh[i]=0;
    misc[i]=0;
    deficit[i]=0;
    erainfall[i]=0;
    houses[i]=0;
    surplus[i]=0;
    totalreq[i]=0;
    totalsupply[i]=0;
    }
    printf("ENTER THE NUMBER OF PERSONS PRESENT
IN THE HOUSE: \n");
    scanf("%ld",&person);
    printf("ENTER ROOF AREA: \n");
    scanf("%ld",&roofarea);

    for(i=1;i<=n;i++)
    {
    printf("ENTER THE RAINFALL (mm): \n");
    scanf("%lf",&rainfall[i]);
    printf("ENTER PRESENT SUPPLY BY ESTATE OFFICE
\n");
    scanf("%ld",&estate[i]);
    erainfall[i]=rainfall[i]*0.85;
    //temp1=effrainfall[i]*100;
    //effrainfall[i]=(float)temp1/100;
    drinkw[i]=person*7*2;
    cookw[i]=person*7*5;
    bathw[i]=person*7*35;
    washh[i]=person*7*10;
    houses[i]=person*7*60;
    misc[i]=person*7*23;
    totalreq[i]=drinkw[i]+cookw[i]+bathw[i]+washh[i]+
houses[i]+misc[i];
```

```
totalhar[i]=(erainfall[i]*roofarea);
totalsupply[i]=totalhar[i]+estate[i];
temp=totalsupply[i]-totalreq[i];
if(temp < 0)
deficit[i]=abs(temp);
else
surplus[i]=temp;
rupeessaved[i]=(totalhar[i]*30)/1000;
totald=totald+deficit[i];
totals=totals+surplus[i];
sumtotalreq=sumtotalreq+totalreq[i];
sumtotalsupply=sumtotalsupply+totalsupply[i];
}
clrscr();
printf("\n");
printf(" WATER BUDGET CALCULATION \n");
printf("\n");
printf("————————————————————————————\n");
printf("std week RF ERF drinking cooking bathing washing household miscll totalD totalHAR estateS totalS deficit surplus\n");
for(i=1;i<=n;i++)
printf("%ld\t%2.2lf\t%2.2lf\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld\t%ld|\n",i,rainfall[i], erainfall [i],drinkw[i],cookw[i],bathw[i],washh[i],houses[i], misc [i],totalreq[i],totalhar[i],estate[i],totalsupply[i],deficit[i], surplus[i]);

printf("————————————————————————————\n");
printf("SUMMATION |%ld| %ld| %ld|%ld ",sumtotalreq,sumtotalsupply,totald,totals);
getch();
}
```

'C' programme to design rooftop rainwater harvesting structure in residential blocks:

```
#include<stdio.h>
#include<math.h>
main()
{
int i,j,k;
float ri,ra,rq,rt,rq1;
float rn,rs,rx,rxt;
float h,f,ht,d,dt;
float  un,us,ud,udt;
float vis,dv,dp,dw,r,dl,db,t;
float fr,fa,fb,fl;
float rd,rc,v,sb,sl,sd;
clrscr();
printf("\n Rainfall intensity (30 min maximum) in mm/hr =");
scanf("%f",&ri);
printf("\n Roof Area for one gutter in sq. metre =");
scanf("%f",&ra);
rq=ri*ra/3600000;
printf("\n Total Flow from Roof Area is %f cu. metre/ sec.",rq);

printf("\n\n Mannings roughness coefficient for the roof surface =");
scanf("%f",&rn);
printf("\n Slope of the roof surface in fraction =");
scanf("%f",&rs);
rxt=(0.9873*rq*rn)/sqrt(rs);
rx=pow(rxt,0.375);
printf("\n Gutter r=%f",rx);

printf("\n\n Available head causing flow in metre=");
scanf("%f",&h);
printf("\n Darcy's Roughness coefficient =");
scanf("%f",&f);
printf("\n Height of the down pipe in metre=");
scanf("%f",&ht);
dt=(rq*sqrt(f*ht))/(1.74*sqrt(h));
d=pow(dt,0.4);
printf("\n Diametre of down pipe = %f metre",d);
printf("\n Total Roof area of the building is sq.metre =");
scanf("%f",&rt);
rq1=ri*rt/3600000;
printf("\n\n Manning's roughness coefficient for underground pipe=");
scanf("%f",&un);
printf("\n slope of the underground pipe line in fraction=");
scanf("%f",&us);
udt=(rq1*un)/(0.4936*sqrt(us));
ud=pow(udt,0.375);
printf("\n Diametre of under ground pipe = %f metre",ud);

printf("\n\n Viscosity of water = ");
scanf("%f",&vis);
printf("\n Vertical distance through which particle falls=");
scanf("%f",&dv);
printf("\n Density of particle = ");
scanf("%f",&dp);
printf("\n Density of water=");
scanf("%f",&dw);
printf("\n Radius of particle=");
scanf("%f",&r);

t=(0.03*vis*dv)/((dp-dw)*4*r*r);
dl=pow((1.5*rq1*t),1.67);
```

```
db=dl/1.5;
printf("\n Length and breadth of detension tank  = %f x %f metre",dl,db);

printf("\n Rate of filteration for 1 m depth in cu.m/min-sq.m =");
scanf("%f",&fr);
fa=rq1*60/fr;
fb=sqrt(fa/1.5);
fl=1.5*fb;
printf("\n Length and width of settling tank are = %f x %f metre",fl,fb);

printf("\n Depth of rainfall in mm =");
scanf("%f",&rd);
printf(«\n Runoff Co-efficient for the roof surface =»);
scanf("%f",&rc);
printf(«\n Depth of storage tank desired =»);
scanf("%f",&sd);
v=(rd/1000)*rt*rc;
sb=sqrt(v/(1.5*sd));
sl=1.5*sb;
printf("\n Length and width of storage tank are = %f x %f metre",sl,sb);
clrscr();
printf("\n\n\t\tThe System specifications for RTWH are::\n");
printf("\n Gutter r=%f",rx);
printf("\n Diametre of down pipe = %f metre",d);
printf("\n Diametre of under ground pipe = %f metre",ud);
printf("\n Length and breadth of detension tank  = %f x %f metre",dl,db);
printf("\n Length and width of settling tank are = %f x %f metre",fl,fb);
printf("\n Length and width of storage tank are = %f x %f metre",sl,sb);
}
```

'C' programe to design rooftop rainwater harvesting structure in hostel building:

```
#include<stdio.h>
#include<math.h>
main()
{
char ch;
double mm,min,h,l;
double rf,flow,roof_area,r,f,d,n,s,n1,s1,pvc,depth,b2,l2, terr,w_harvest;
double mue,Dv,Dp,D,t,b,rf1,flow1,filt,area_req,b1,l1,rain, water_coll;
clrscr();
printf("\nenter RF intensity in mm/min\n");
scanf("%lf%lf",&mm,&min);
rf=mm/(1000*min*60);
printf("enter the total rooftop area\n");
scanf("%lf",&roof_area);
flow=roof_area*rf;
printf("enter the head, darcy's coeff for asbestos pipe,length of the downpipe\n");
scanf("%lf%lf%lf",&h,&f,&l);
d=pow((flow*pow(f,0.5)*pow(l,0.5))/(1.74*pow (h,0.5)),0.4);
printf("enter the mannings roughness coefficient for PVC pipe and slope upto detension\n");
scanf("%lf%lf",&n1,&s1);
pvc=pow((flow*n1)/(0.4936*pow(s1,0.5)),0.375);
printf("enter the viscosity mue,Vertical distance Dvand density of the particle Dp\n");
scanf("%lf%lf%lf",&mue,&Dv,&Dp);
printf("enter the density of the water D and radius of the particle r\n");
scanf("%lf%lf",&D,&r);
t=(0.03*mue*Dv)/((Dp-D)*4*r*r);
l=pow((flow*1.5*t),0.333);
b=l/1.5;
rf1=mm/(min*1000);
flow1=roof_area*rf1;
printf("enter the rate of filtration \n");
scanf("%lf",&filt);
area_req=flow1/filt;
b1=pow((area_req/1.5),0.5);
l1=1.5*b1;
printf("enter the max weekly rainfall\n");
scanf("%lf",&rain);
water_coll=roof_area*(rain/1000);
printf("enter the runoff coefficient over the open terrace\n");
scanf("%lf",&terr);
w_harvest=water_coll*terr;
printf("enter the desiered depth of rectangular tank\n");
scanf("%lf",&depth);
b2=pow((w_harvest/(1.5*depth)),0.5);
l2=1.5*b2;
printf("————————————————————————————————\n");
printf("RFintensity=%lf\n max discharge=%lf\n down pipe dia=%lf\n PVC pipe dia=%lf\n",rf,flow,d,pvc);
printf("Time req for particle to settle=%lf\n L of detention basin=%lf\n B of detention basin=%lf\n R.F in m/min=%lf\n Discharge per min=%lf\n",t,l,b,rf1,flow1);
printf("Area req for filtration=%lf\n L of filtration tank=%lf\n B of filtration tank=%lf\n",area_req,l1,b1);
printf("total water can be collected=%lf\n total water harvested=%lf\n B of storage tank=%lf\n L of storage tank=%lf\n",water_coll,w_harvest,b2,l2);
getch();
}
```

REFERENCES

Gopinath, K.R. (2000). Rainwater harvesting. Proceedings of National Seminar on Rainwater Harvesting, Vigyan Bhawan, New Delhi, 22-23 May: 111-117.

Gould, J. (2000). Rainwater catchment systems. Reflections and prospects. *Water Lines*, **18**(3): 2-5.

Ministry of water resources (1998). Utilization of rainwater, Bhagirath, July-September: 166.

Gould, J. E. (1996). Rainwater utilization in Botswana: Problems and possibilities, Botswana. *Sci. Tech. & Development*, **14**(3): 72-87.

Bali, J.S. (1988). Farm practices, management of water harvesting system in the catchment areas. *J. Soil & Water Conservation*, **32** (1 & 2): 129-130.

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