EXAMINING THE IMPACT OF CLIMATE CHANGE ON RESERVOIR RELIABILITY

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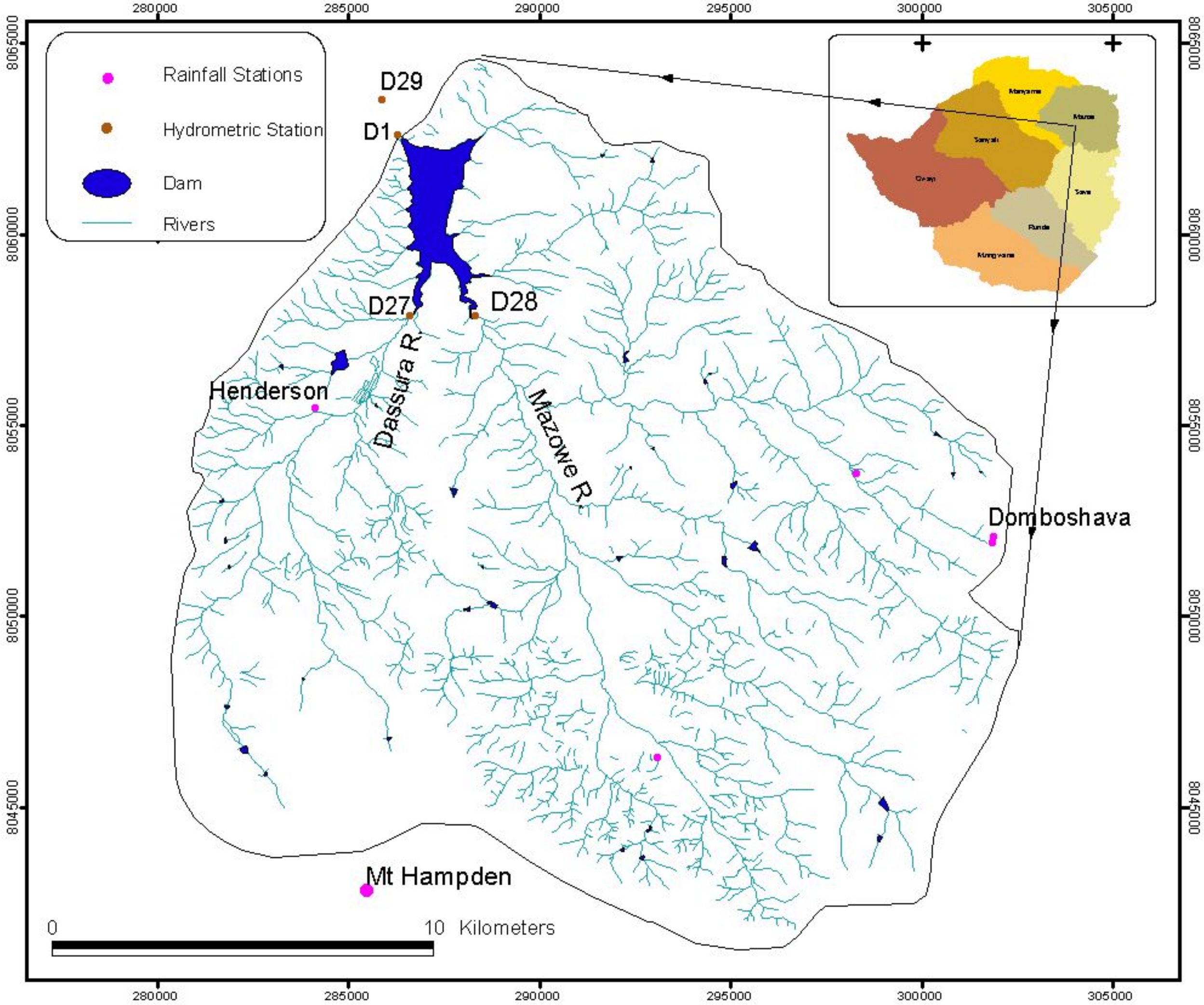
Introduction

- Effective planning, development and allocation of water resources are keys to achieve MDGs
- However human and natural challenges affect sound water resources management
- Climate change is significantly affecting total flows, frequencies of floods and droughts
- There is need make reliable predictions of the likely impacts of climate change on water resources
- This paper therefore aims at examining the impacts of climate change on reservoir reliability

Location of study area



Description of study area

- Mazowe Dam (17°31'18"S, 30°59'19"E) was built across the Mazowe River in 1918 for irrigating citrus fruits and annual crops
- The dam's catchment is 355 km^2
- Receives an average rainfall of 864 mm/yr
- Mean annual temperature of about 21^0C
- A-pan evaporation rate is 1630 mm/year
- Reservoir has a full supply capacity of 44.6×10^6 m^3 with a surface area of 5.4 km^2

Data

- Monthly meteorological and hydrological data were obtained from responsible state agencies
- Data spanned 30 years (1961-1990) represented the baseline (1CO2) condition
- Temperature and rainfall data from the Canadian Climate Centre model (lat. x lon: 3.75^0 x 3.75^0) represented the IPCC 2CO2 scenario (doubling of carbon dioxide in 2050)

Penman model

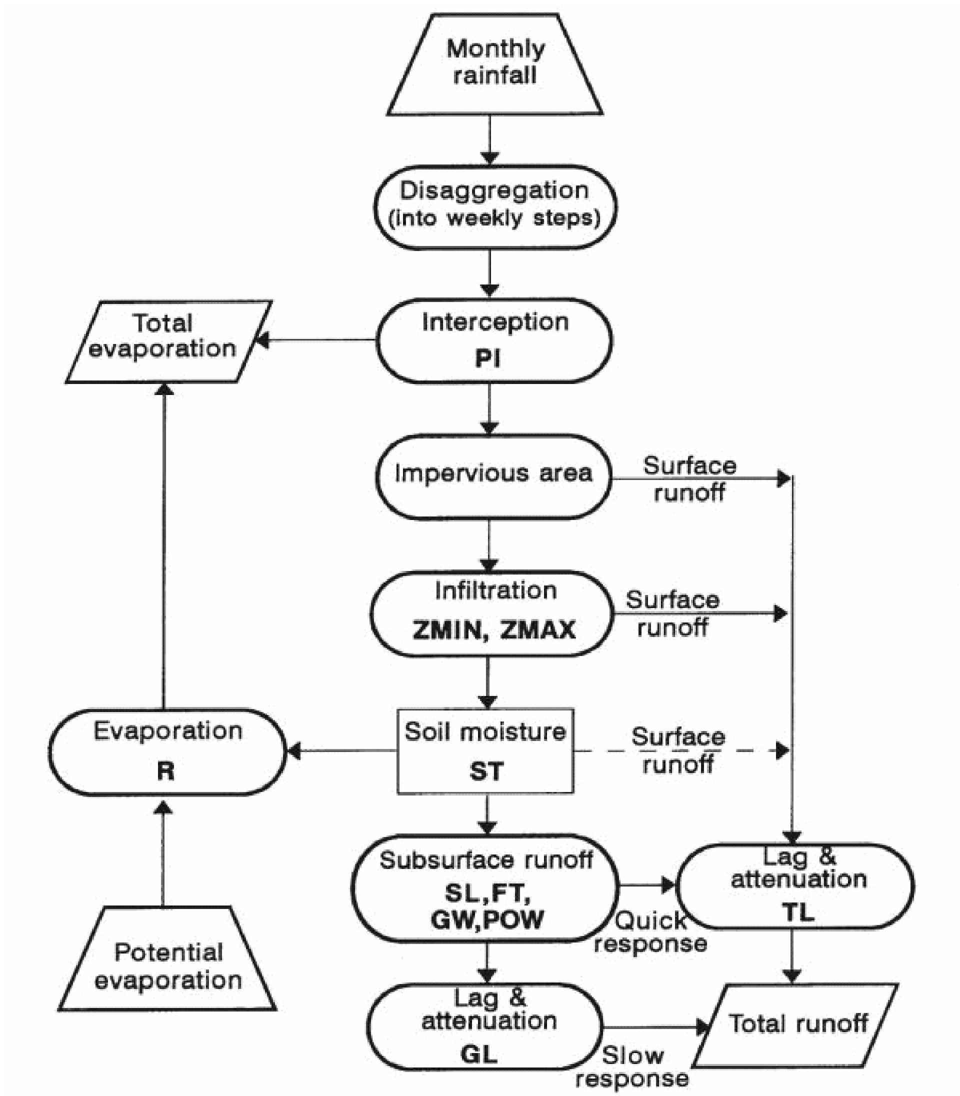
- Estimate PET, E_o
- Change in vapour pressure with time
- Hydrometric constant (=0.27mmHg/temperature
- H-is the available heat, f(albedo, radiation)
- E_a- f(wind speed and vapour pressure deficit)

$$E_o = \Delta/\gamma\, H + E_a/(\Delta/\gamma + 1)$$

Pitman rainfall-runoff model

- Simulate the catchment runoff using monthly precipitation and E_0
- Precipitation data were obtained from the Dept of Meteorological Services
- Average precipitation for the 5 stations estimated to give the areal data
- E_o data were obtained as output from the Penman model
- Model's Rosenbrock technique reproduces a goodness of fit between the predicted and observed values

Pitman model flow chart



Pitman model parameters

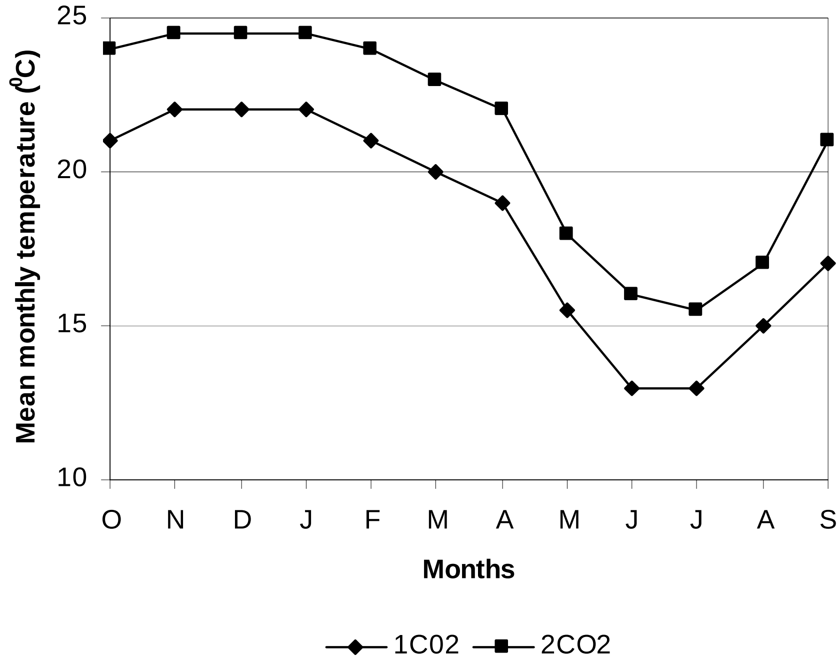
Parameter		Value	Units	Description
Monthly Time Series	P		mm/month	Monthly rainfall
	PE		mm/month	Monthly total evaporation
Non-temporal Parameters	POW	3	-	Power of soil moisture-runoff equations
	SL	0.0	mm	Soil moisture storage below which no runoff occurs (~wilting point)
	ST	769.8	mm	Maximum soil moisture capacity (~porosity/saturation)
	FT	2.2	mm/month	Runoff from soil when soil moisture is at full capacity
	GW	4	mm/month	Maximum groundwater runoff
	AI	5	%	Impervious portion of the catchment
	ZMIN	70.6	mm/month	Minimum catchment absorption rate
	ZMAX	573.7	mm/month	Maximum catchment absorption rate
	PI	20	mm	Interception storage
	TL	0.25	months	Lag of surface runoff
	GL	1.4	months	Lag of runoff from soil moisture
	R	0.5	-	Evaporation-soil moisture storage relationship

Reservoir Yield Program

- Obtained from ZINWA
- Simulate changes in the reservoir yields at 10% risk level
- Uses catchment area, CA
- MAR,MAP, CV of rainfall and runoff
- E_o and drawoff (1 500 m^3)
- Upstream storage(0) and reservoir full volume
- Storage ratio (FSC/ MAR*CA)> 0.5

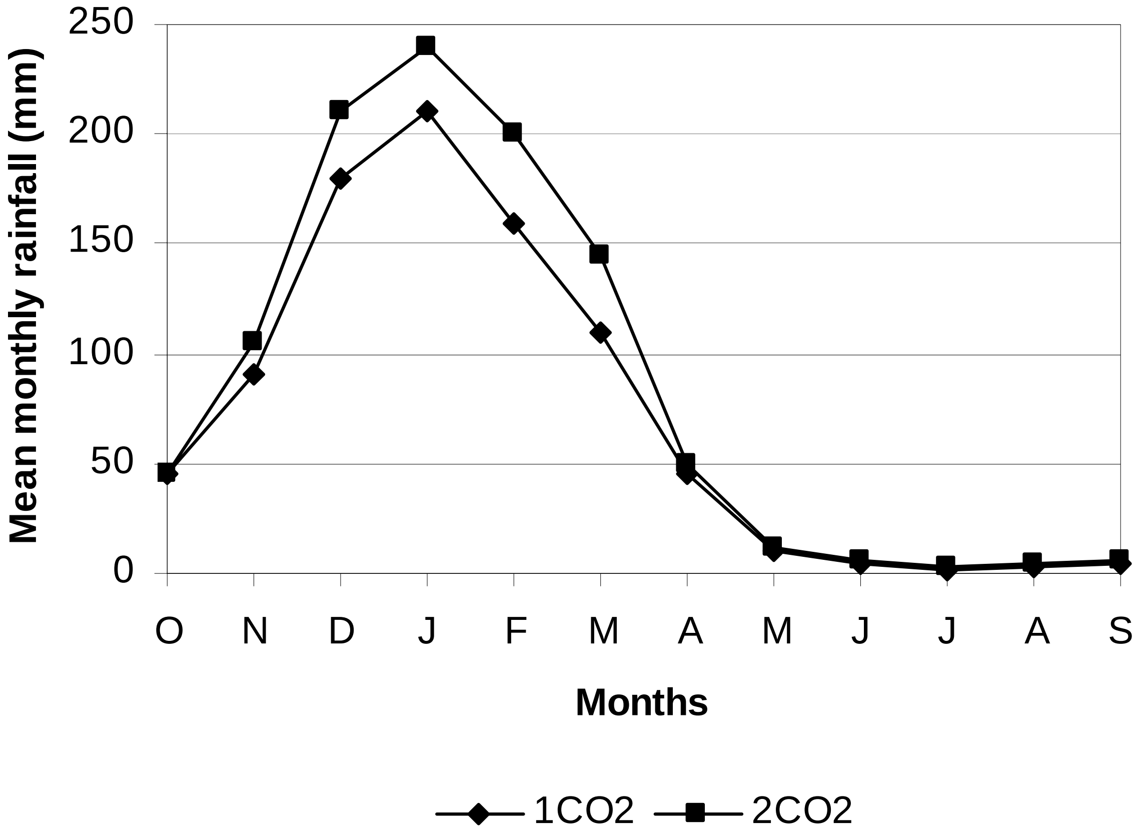
Changes in temperature

- $2CO_2$ -mean annual temperature will increase by 16.3% or 3^{0}C from the baseline condition.
- Average monthly temperature for $1CO_2$ of 18.38 ^{0}C is significantly ($p=0.000$) lower than 21.17 ^{0}C for the $2CO_2$.



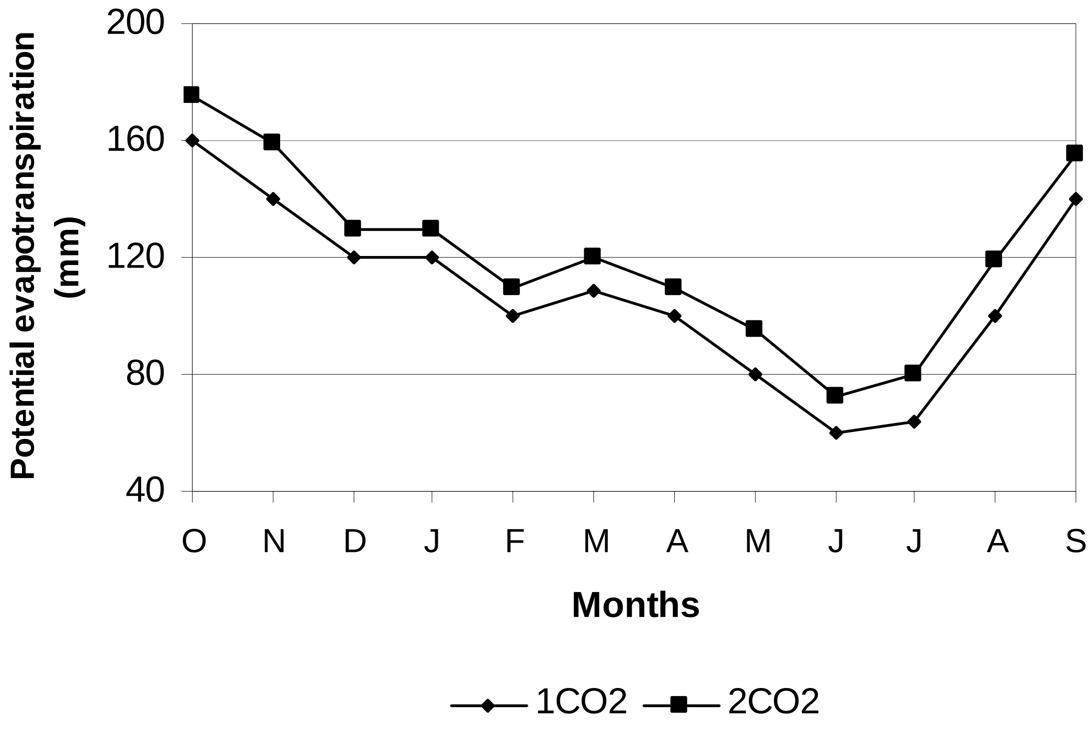
Changes in precipitation

- Monthly precipitation will significantly (p=0.013) increase by 15% from 72.08 mm to 83 mm



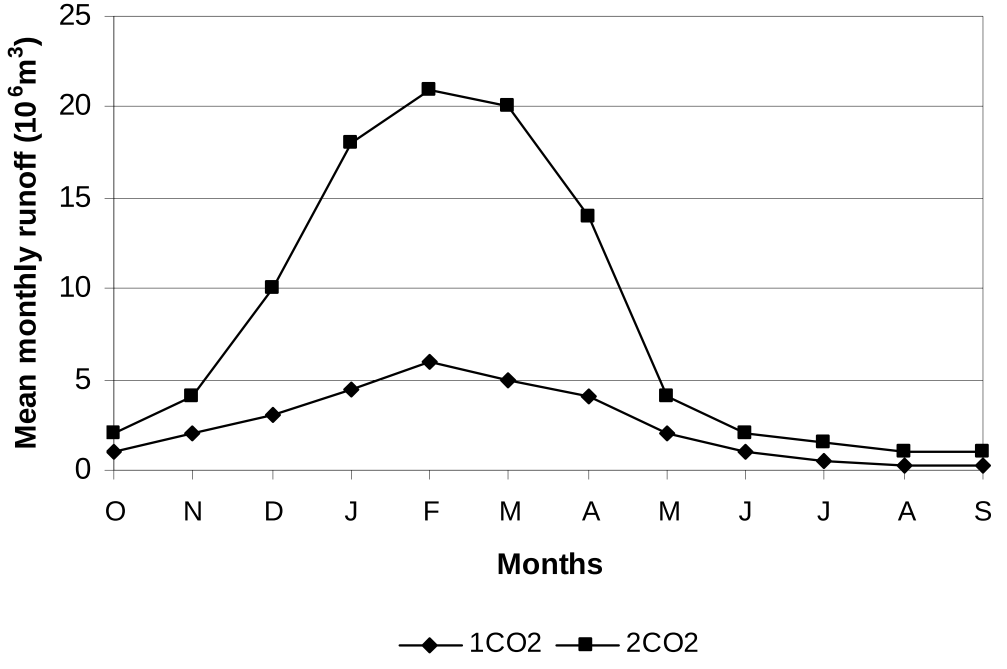
Climate change and ET

- Monthly E_o will significantly (p=0.000). increase by 11.8% from the baseline value of 107.75 mm.



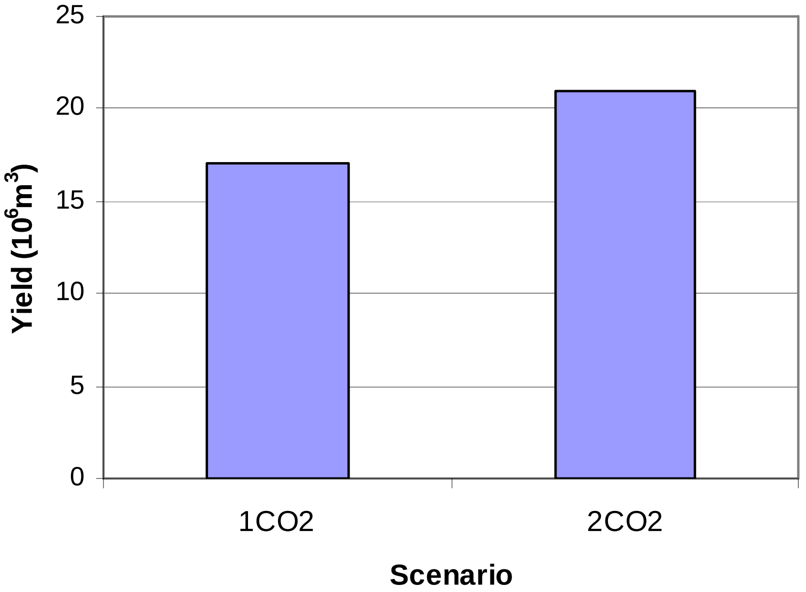
Changes in runoff

- 2CO2 mean monthly runoff will significantly ($p=0.007$) increase by 235%
- Baseline mean annual runoff of 2.45 x $10^6 m^3$ is significantly lower than 8.21 x $10^6 m^3$ for 2CO2



Changes in annual reservoir yield

- Mean annual reservoir yield will increase by 20.4% from the 1961-1990 baseline average
- Increase in reservoir yield will have a positive effect on irrigated agriculture because water will be available.



Summary

Variable	% change
Temperature	16.3
Precipitation	15
PET	11.8
Runoff	235
Reservoir yield	20.4

Conclusions

- With doubling of carbon dioxide, Anticipated doubling of carbon dioxide will significantly ($p<0.05$) increase water balance parameters.
- Area under irrigation will need to be expanded to utilise high reservoir yields
- Potential flooding with increase in runoff
- Appropriate measures against high evaporation rates need to be employed.

Acknowledgements

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The end

Thank you

Tatenda