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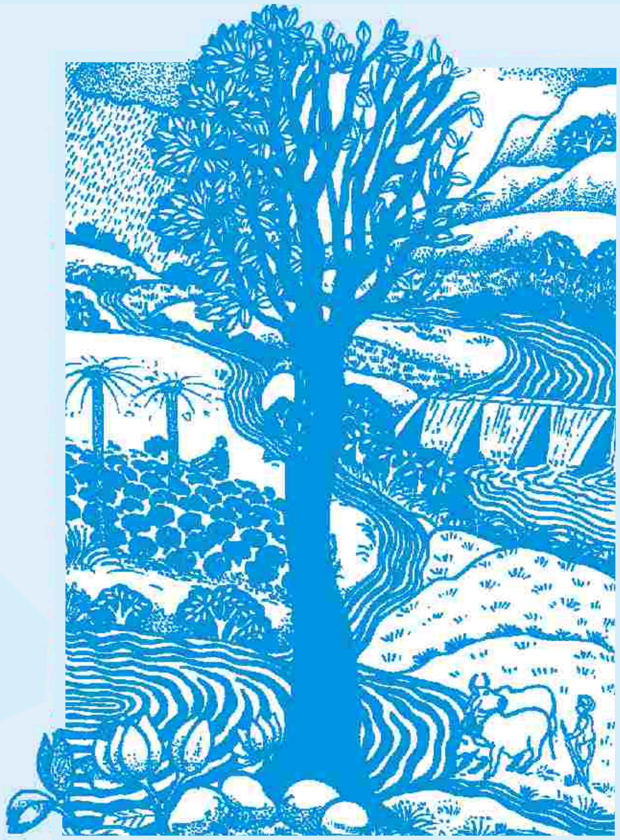
Highlight

Which Water Counts? Blue and Green Water Use and Productivity in the Narmada Basin

M. Dinesh Kumar
and
O. P. Singh



Narmada, a trans-boundary river basin, has seen a decade-long legal battle for allocation of basin water resources amongst four contesting states. The basin has undergone several changes, particularly on land use in the form of changes in cropping systems. Irrigation water use has increased from a mere 0.62 BCM to a staggering 4.53 BCM over the last three decades, whereas green water use at the aggregate level has increased slightly from 16.58 BCM to 17.52 BCM. The annual size of agricultural economy in Madhya Pradesh (MP) part of the basin, in terms of the gross value product, is estimated to be Rs. 68.73 billion. Nearly 52.9 percent of this is generated from green water use. The net value product from crop production in this part of the basin is Rs. 29.37 billion and 61.76 percent (18.31 BCM)of this comes from green water use.

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Which Water Counts? Blue and Green Water Use and Productivity in the Narmada Basin [1]

Research Highlight Based on a Paper Titled: "the Blue and Green Water Use and Productivity in Agriculture: Study From Narmada River Basin, Madhya Pradesh, India"

Context

Globally, two major water-dependent interests are in conflict today: food security and ecological security. In water scarce regions or basins, increasing diversion of water for irrigation can have major environmental impacts. When water becomes scarce, the only way to enhance food production, without further negative effects on the environment is enhancing crop water productivity. So far research has primarily focussed on enhancing the productivity of blue water. Little attention has been paid to enhancing productivity of green water, though there are isolated studies to analyze the impact of supplementary irrigation in rain-fed crops.

Narmada basin is a trans-boundary river basin which has seen a decade-long legal battle for allocation of basin water resources amongst the four contesting states. In view of the recent observations of reduced observed flows in the Narmada river, concerns have been raised about the ability to realize the planned utilization of 28 million acre feet (MAF) of water. The Narmada Water Disputes Tribunal (NWDT), which was empowered to allocate the basin's water resources among the party states, had allocated only the surface flows in the basin. Since the tribunal allocation in 1979, the basin has undergone several changes, particularly on land use in the form of changes in cropping systems. Such changes are likely to have significant implications for the sanctity of water allocation done by NWDT as it is likely to affect blue water availability by increasing the use of the green water component of the basin's water use.

Objectives

The objectives of the paper are: (1) to estimate the extent of blue and green water use for agricultural production in MP part of the basin; (2) to analyze the differential impact of optimal use of green and blue water on farm outputs and economic returns over rain-fed production in selected crops; (3) to estimate the agronomic and economic efficiency of green and blue water, and combined water productivity; (4) to analyze the differential impact of optimal use of green and blue water on water use efficiency (agronomic and economic efficiency) in crop production; and (5) to estimate the contribution of blue and green water use to the agricultural economy of MP part of the basin.

Results and Discussion

Crops Using Green Water and Blue Water

One needs to make a distinction between blue and green water productivity of crops and the extent of use of blue and green water in those crops. There are some crops in which the extent of use of green water is quite significant, such as paddy in some regions and cotton. But we have not estimated the productivity of green water for these two crops because growing them without irrigation is not possible in some regions of the

[1]The research covered by this IWMI-Tata Research Highlight was carried out with generous support from Sir Ratan Tata Trust, Mumbai under IWMI-Tata Water Policy Program. The research paper can be downloaded from the IWMI-Tata Website http://www.iwmi.org/iwmi-tata.

Narmada basin. We have assumed the yield corresponding to green water use to be zero and, therefore entire crop yield is attributed to irrigation water use.

There are other kharif crops which are heavily dependent on rainwater, but often receive some supplementary irrigation from groundwater and other sources. Even for the same crop, say paddy in the central Narmada valley and the northern hill region of Chhattisgarh, some farmers depend entirely on rainfall while others provide some amount of supplementary irrigation. In such cases, we have segregated the contribution of green and blue water to total yield. In estimation of green water use, all crops where rainwater is effectively used are considered, irrespective of whether the crop gives green water productivity or not. We have also estimated the combined water productivity along with green and blue water productivity for crops having conjunctive use of rainwater and diverted water.

Irrigation water use in the basin has increased dramatically over the last three decades, from a mere 0.62 BCM to a staggering 4.53 BCM.

Estimates of Quantum of Blue Water Use for Different Crops

Blue water use in the basin was estimated for different time periods (from 1970-71 to 1999-00) at time intervals of 5 years, on the basis of; 1) water use rates estimates arrived at for the seven different agro-climatic regions (covering nine districts) for 2003-2004; and 2) the irrigated cropping pattern. Here it is assumed that the current irrigation water use rates for the same crops have not changed over the years though, for a particular crop, the percentage of area under irrigation would have changed. The analysis captures two important changes in the basin. First, cropping intensity has increased and second, for the same crop, area under irrigation has increased. There has been a dramatic growth in irrigation water use over 30 years, from a mere 0.62 BCM to a staggering 4.53 BCM (Table 1). However, the growth is not uniform across regions. The highest growth was recorded in the central Narmada valley (9.25 percent/annum) and lowest growth was found in the Chhattisgarh plains (3.85 percent/annum) while the average growth rate for the basin was 7.31 percent/annum.

Table 1: Blue Water Use in MP Part of the Narmada Basin (1970-71 to 1999-00).

Year	Central Narmada Valley	Vindhya Plateau	Satpura Plateau	Northern Hill Region of Chhattisgarh	Malwal Plateau	Nimar Plains	Jhabua Hills	Chhattisgarh plains	Kymore Plateau & Satpura Hills	Basin Total
1970-71	0.14	0.09	0.06	0.01	0.12	0.17	0.01	0.01	0.01	0.62
1975-76	0.28	0.09	0.08	0.01	0.19	0.25	0.01	0.03	0.01	0.95
1980-81	0.43	0.10	0.11	0.02	0.27	0.43	0.03	0.02	0.01	1.41
1985-86	0.57	0.18	0.13	0.03	0.29	0.38	0.02	0.03	0.02	1.64
1991-92	1.21	0.28	0.14	0.05	0.49	0.83	0.05	0.02	0.04	3.12
1995-96	1.39	0.36	0.20	0.05	0.58	1.02	0.08	0.03	0.07	3.77
1999-00	1.83	0.32	0.26	0.04	0.67	1.26	0.05	0.03	0.09	4.53
99-00/ 70-71	9.25	3.58	4.33	4.00	5.58	7.41	5.00	3.00	9.00	7.31
All Figures are in BCM										

Source: Authors' estimates

Quantum of Green Water Use for Different Crops in the Basin

Green water use at the basin level would depend on several factors: area under crops which use rainwater in the form of soil moisture and direct *in situ* water harvesting such as in the case of paddy, seasons during which crops grow, and duration of the crop. Even irrigated crops like sugarcane, paddy, and cotton use green water. Greater the crop duration, higher would be green water use for transpiration and evaporation of soil moisture from cropped fields.

Many crops which farmers previously used to grow under rainfed condition are now irrigated. With increased access to irrigation facilities, farmers do not wait for rains and suffer crop losses owing to reduced soil moisture for evapo-transpiration (ET) demand. Instead, they irrigate their crops with the water available in their wells to get optimum yields. One reason for such a change in agronomic practices is the increasing adoption of high yielding varieties which are highly sensitive to water stress, which itself is an outcome of increased access to irrigation facilities. In such cases, the actual consumptive water use would be much higher than in the case of rainfed crops and closer to ET requirements. This can lead to overestimation of the actual effective rainwater use for the past years since we are assuming the consumptive use as crop water requirement for rainfed crops.

The analysis shows that green water use at the basin level has increased slightly from 16.58 BCM to 17.52 BCM (Table 2). However, a closer look at the regional level figures shows that the increase in green water use has occurred only in some regions like the central Narmada valley, Vindhya plateau, and Malwal Plateau, whereas in the Nimar plains, Chhattisgarh plain, and northern hill regions of Chhattisgarh, green water use has actually gone down. In other regions, no notable changes have occurred.

Total water use in agriculture is the sum of water drawn from soil moisture and the consumptive fraction of applied water. Given the profile of change in blue and green water use in agriculture in the basin, the composition of water use in agriculture has changed remarkably. As per our estimates, the share of blue water in total agricultural water withdrawal was only 3.74 percent in 1970-71. This has gone up to 20.54 percent in 1999-2000 (Figure 1).

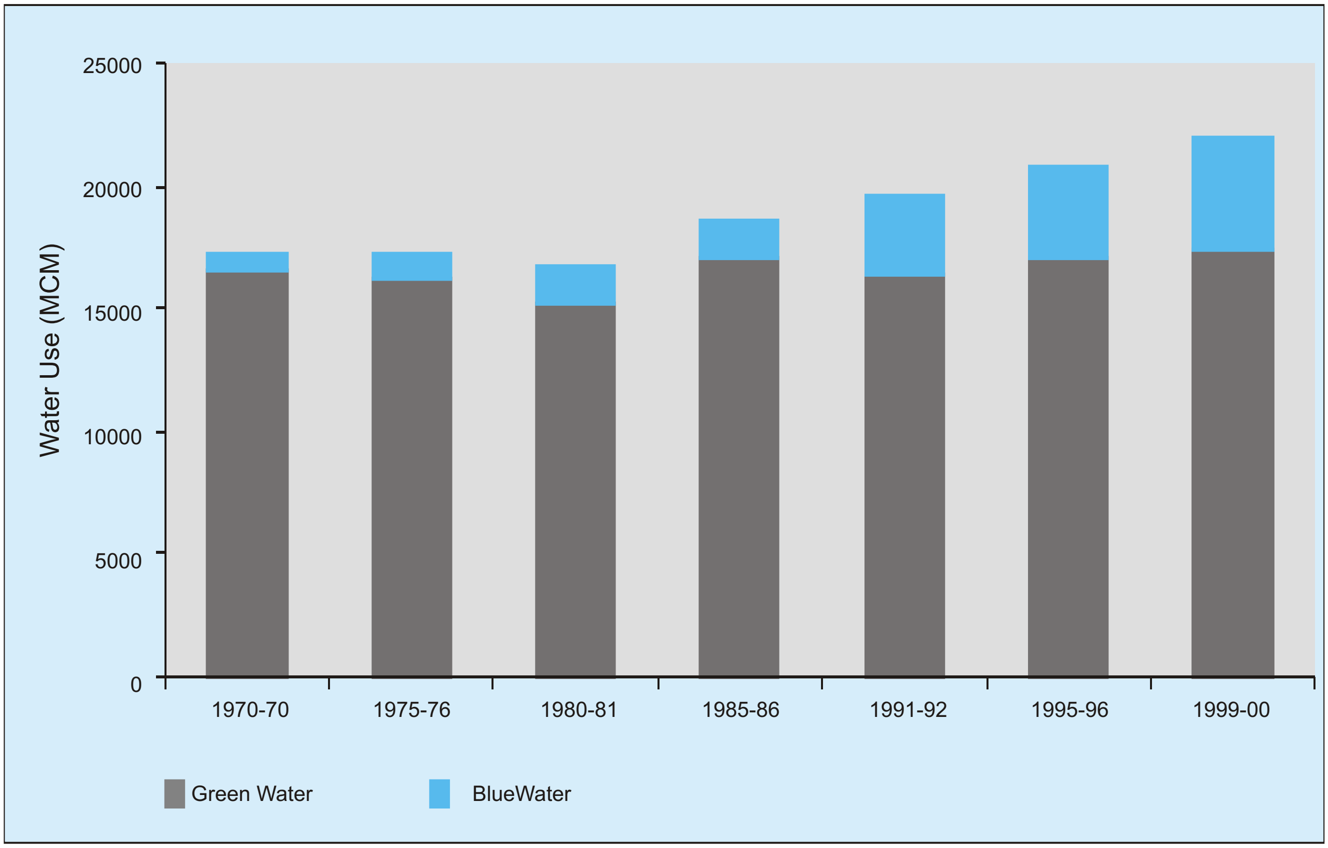
The contribution of green water to overall agricultural output in the basin is quite significant. Of the total gross and net value product of agriculture, green water accounts for nearly 52.9 percent and 61.76 percent respectively.

Table 2: Green Water Use in Madhya Pradesh Part of Narmada River Basin (1970-71 to 1999-00)

Year	Central Narmada Valley	Vindhya Plateau	Satpura Plateau	Northern Hill Region of Chhattisgarh	Malwal Plateau	Nimar Plains	Jhabua Hills & Malwal Plateau	Chhattisgarh plains	Kymore Plateau & Satpura Hills	Basin Total
1970-71	3.44	1.67	1.01	1.47	2.63	4.95	0.81	0.24	0.35	16.58
1975-76	3.23	1.39	1.03	1.53	2.62	5.11	0.84	0.23	0.35	16.34
1980-81	3.11	1.40	0.82	1.04	2.58	5.14	0.72	0.21	0.29	15.32
1985-86	3.52	1.60	1.07	1.60	2.70	5.17	0.77	0.23	0.39	17.05
1991-92	3.37	1.71	1.10	1.54	2.75	4.69	0.80	0.22	0.27	16.44
1995-96	4.05	1.67	1.04	1.31	2.89	4.75	0.79	0.20	0.34	17.05
1999-00	4.02	1.99	1.05	1.34	3.21	4.50	0.84	0.21	0.35	17.52
70-71/ 99-00										1.055
All Figures are in BCM										

Source: Authors' estimates

Figure 1: Historical Growth in Agricultural Water Use in the Narmada River Basin, M.P.



Source: Authors' estimates

Economic Output from Green and Blue Water Use in Different Regions

Gross and net economic outputs from agricultural water use have been estimated using two variables: 1) volume of water used for each crop in a particular region; and 2) water productivity of the crop, estimated separately for blue water and green water. The volume of water used for each crop is estimated on the basis of area under the crop and water use (applied water or effective rainfall depending on whether the crop is irrigated or rainfed). Here, the total water diverted is used for estimating value outputs instead of the net consumptive use of water. The economic outputs (both gross and net) of different crops are aggregated first at the district level and then at the regional level to arrive at the total size of the agricultural economy.

As table 3 shows, both gross and net value product from green water use are quite significant. The annual gross value product of agriculture in MP part of the basin is Rs. 68.73 billion. Nearly 52.9 percent of this value (Rs. 36.38 billion) is generated from green water use. The net value product of crop production is Rs. 29.37 billion and 61.76 percent of this comes from green water use.

The regional variation in water dosage rates is attributable to two factors: availability of soil moisture depending on the magnitude of rainfall and evapo-transpiration requirement of crops.

Temporal and Spatial Variability in Water Productivity

Water application rates vary from region to region and from year to year for the same crop. In drought years, water use rate for the same crop is generally higher compared to normal years, though in certain instances it is found to be the opposite. In drought years, the availability of soil moisture is lesser, ET higher, and therefore irrigation water requirement is higher. Farmers who have access to irrigation increase the water dosage to meet the ET demand of crops. On the other hand, farmers not having adequate water in their wells fail to provide sufficient irrigation. The reasons for regional variations in water dosage rates are differential availability of soil moisture depending on the magnitude of rainfall and evapo-transpiration requirement of crops. The *in situ* use of rainwater is also quite significant. Water usage rates range from 428.5 mm to 520.65 mm

Table 3: Gross and Net Value Product from Blue and Green Water in Agriculture

Name of the Region	Value Product (million rupees) from Agricultural Water Use from			
	Blue Water		Green Water	
	Gross	Net	Gross	Net
1. Central Narmada Valley	9875.66	3556.52	10762.87	4474.17
2. Vindhya Plateau	2311.40	1072.84	4062.97	2539.76
3. Satpura Plateau	1679.88	731.89	1753.84	815.56
4. Malwa Plateau	6142.20	1802.31	9703.14	4675.62
5. Nimar Plains	11378.98	3879.17	7931.42	4732.09
6. Northern Region of Chhattisgarh	379.08	106.10	571.66	228.97
7. Jhabua Hills	137.68	36.74	186.45	221.89
8. Chhattisgarh Plains	109.88	39.67	587.19	263.52
9. Kymore Plateau and Satpura Hills	338.10	108.94	820.17	255.38
Basin Total	32352.87	11334.08	36379.71	18306.95

Source: Authors' estimates

in the case of soya-bean; 349.1 mm to 429.1 mm in the case of black-gram; 387.2 mm to 465.2 mm in the case of maize; and 460.5 mm to 509 mm in the case of paddy. These are quite significant when compared to the rainfall of these regions.

There is a strong inverse correlation between irrigation water applied and water productivity. When applied water was lower, productivity was higher.

A strong inverse correlation exists between irrigation water applied and water productivity. In all cases except one, value of water productivity in a typical year was found to be determined by whether applied water was higher or lower. When applied water was lower, productivity was higher. This means that irrigation corresponding to the year of "higher water dosage" is, by and large, in the economically inefficient regime where the marginal increase in water application does not result in a sufficiently high marginal increase in net income gain. Only in case of the Malwal plateau, water productivity (Rs/m^3) was higher during the drought year in spite of the fact that average water application in that year was slightly higher than the normal year.

Spatial analysis of water productivity is an important aspect of the strategy to enhance water productivity at the agro-climatic level (Table 4), as productivity of applied water is a function of agro-climate. In regions with favourable climatic conditions, the biomass output per unit of water evapo-transpired would be higher than in regions with less favourable climate. Here, we have compared water productivity of wheat and paddy, two important cereal.

In wheat, the physical productivity of applied water in a normal year was the highest for the northern hill region of Chhattisgarh in Mandla district (1.80 kg/m^3) and the lowest for Jabalpur in the central Narmada valley (0.47 kg/m^3) (Table 5). This is mainly because of the difference in irrigation water applied: 127 mm in Mandla against 640 mm for Jabalpur. The difference in irrigation can be attributed to the difference in climate between Jabalpur (dry semi-humid) and Mandla (moist sub-humid), which changes crop water demand. Higher biomass output per unit volume of water (physical productivity) should also result in higher economic output especially when the difference is mainly arising from climatic factors, which changes ET requirements, unless the factors which determine the cost of inputs significantly differ. The net economic

Table 4: Region-wise Net Economic Water Productivity (Rs/m^3)

Name of the Region	Name of the district	Blue Water Productivity		Green Water Productivity	
		Crop with highest value/ Net Water Productivity	Crop with lowest value/ Net Water Productivity	Crop with highest value/ Water Productivity	Crop with lowest value/ Water Productivity
Central Narmada Valley	Hoshangabad	Gram (Rs 6.81)	Wheat (Rs. 2.31)	Black-gram (Rs. 3.55)	Paddy (Rs. 1.22)
	Jabalpur	Paddy (Rs. 3.95)	Pea (Rs. 1.02)	Paddy (Rs. 1.55)	Black gram (Rs. 0.22)
	Narshinhpur	Masoor (Rs. 5.57)	Wheat (Rs. 0.86)	Black-gram (Rs. 1.34)	Soya-bean (Rs. 0.68)
Jhabua Hills	Jhabua	Cotton (Rs. 1.59)	Wheat (Rs. 1.20)	Groundnut (Rs. 3.03)	Jowar (Rs. 0.27)
Satpura Plateau	Betul	Masoor (Rs. 7.04)	Wheat (Rs. 2.61)	Sugarcane (Rs. 3.59)	Maize (Rs. 1.26)
Malwa Plateau	Dhar	Chillies (Rs. 6.81)	Wheat (Rs. 2.04)	Cotton (Rs. 6.64)	Pigeon-pea (Rs. 1.17)
Nimar Plains	West Nimar	Chillies (Rs. 4.31)	Wheat (Rs. 1.99)	Groundnut (Rs. 9.17)	Jowar (Rs. 1.31)
Northern Hill Region Chhattisgarh	Mandla	Masoor (Rs. 8.87)	Paddy (Rs. 1.43)	Sugarcane (Rs. 1.51)	of Paddy (Rs. 0.27)
Vindhya Plateau	Raisen	Masoor (Rs. 16.3)	Wheat (Rs. 2.77)	Soya-bean (Rs. 2.68)	Pigeon-pea (Rs. 1.48)

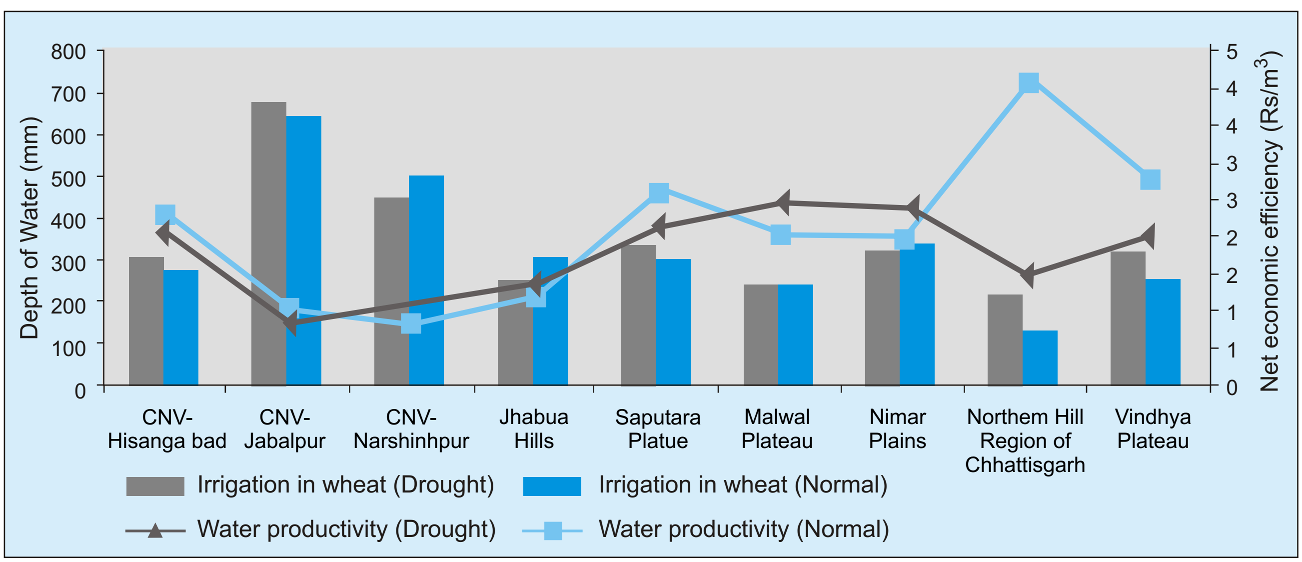
Source: Authors' estimates

Table 5: Region-wise Productivity of Applied Water in Narmada River Basin for Selected Crops

Name of the Region	Name of the District	2002-03 (Drought Year)				2003-04 (Normal Year)			
		Agronomic Efficiency (Kg/m^3)		Economic Efficiency (Rs/m^3)		Agronomic Efficiency (Kg/m^3)		Economic Efficiency (Rs/m^3)	
		Main Product	By-Product	Gross	Net	Main Product	By-Product	Gross	Net
Wheat									
1. Central Narmada Valley	Hoshangabad	0.81	0.81	5.74	2.09	0.91	0.90	6.25	2.31
	Jabalpur	0.44	0.43	3.08	0.89	0.47	0.46	3.42	1.06
	Narsinghpur	0.53	0.49	3.84	1.11	0.49	0.47	3.47	0.86
2. Jhabua Hills	Jhabua	0.73	0.65	5.32	1.38	0.60	0.55	4.69	1.20
3. Satpura Plateau	Betul	0.72	0.73	5.34	2.14	0.84	0.82	6.05	2.61
4. Malwal Plateau	Dhar	1.07	1.02	8.05	2.46	1.05	1.05	7.67	2.04
5. Nimar Plain	West Nimar	0.85	0.83	6.65	2.38	0.83	0.83	6.20	1.99
6. Northern Hill Region of Chhattisgarh	Mandla	0.92	0.88	6.62	1.44	1.80	1.78	12.75	4.09
7. Vindhya Plateau	Raisen	0.77	0.77	5.33	2.00	1.01	1.01	6.82	2.77
Paddy									
1. Central Narmada Valley	Jabalpur	1.08	0.79	5.86	1.99	1.62	1.15	9.36	3.95
2. Northern Hill Region of Chhattisgarh	Mandla	1.74	1.26	11.69	2.12	2.13	1.59	12.50	1.43

Source: Authors' estimates

Figure 2: Irrigation and Water Productivity in Wheat in Drought Year and Normal Year in Different Regions



Source: Authors' estimates

return per cubic metre of water was the highest for the same region for which physical productivity was also higher (Rs. 4.09/m^3), followed by Raisen (Rs. 2.77/m^3). It was the lowest for Narsinghpur (Rs. 0.86/m^3), which had the second lowest physical productivity (Figure 2).

Where Does Green Water Stand in Terms of Water Productivity: Crops like pigeon-pea, soya-bean, maize, jowar, green-gram, black-gram, and groundnut are almost entirely rainfed. Farmers did not irrigate these crops even in a drought year (2002-03). This could be due to poor availability of groundwater. The inadequacy of soil moisture must have reflected in lower yields for most of these crops, though yield reduction could be the result of many factors including lower use of other inputs. This results in lower agronomic efficiencies. But, we have considered the crop water requirements (ET) as the consumptive use in a drought year also. This may not be the case in reality. The crops would have suffered water stress resulting in lower ET (actual). Hence, the assumption would have resulted in some under-estimation of agronomic and economic efficiencies. However, the extent may not be very significant because the ET requirement itself would go up during drought years because of more sunshine and high aridity.

Supplementary irrigation helps enhance yield and water productivity in the case of paddy (as seen in Jabalpur) and cotton (Malwal plateau). The impact is even higher in a drought year.

The net economic returns per unit volume of water are substantial for rainfed crops such as soya-bean and black-gram, and just comparable with the values obtained for some irrigated crops like wheat during normal rainfall years (Table 6). Over and above, the opportunity cost of using rainwater is not as high as water pumped out from aquifers or water from surface reservoirs or rivers. Nevertheless, the net return per unit of water consumed is significantly low during drought years (Table 6).

Table 6: Comparative Analysis of Green Water Productivity of Selected Crops in Normal Year and Drought Year

Sr.No.	Name of Region	Water Productivity of Soya-bean		Water Productivity of Black-gram	
		Drought Year	Normal Year	Drought Year	Normal Year
1	CNV-Jabalpur	-	-	0.14	0.22
2	CNV-Hoshangabad	1.68	2.08	2.56	3.55
3	CNV-Narsinghpur	0.85	0.68	1.16	1.34
4	Jhabua Hills	-	-	1.16	3.03
5	Satpura Plateau	1.24	1.43	-	-
6	Malwa Plateau	1.03	2.36	-	-
7	Nimar Plain	1.00	2.13	-	-
8	Northern Hill Region of Chhattisgarh	-	-	-	-
9	Vindhya Plateau	1.83	2.68	-	-

Source: Authors' estimates
CNV: Central Narmada Valley

There is a need to enhance the productivity of rainfed crops, especially during drought years by providing supplementary irrigation. This is reinforced by our analysis of paddy and cotton, which are grown during kharif season and which receive some irrigation. Supplementary irrigation helps enhance yield and water productivity in the case of paddy (as seen in Jabalpur) and cotton (Malwal plateau). The water productivity impact of supplementary irrigation is higher during drought year.

Conclusions

Spatial analyses of crop water productivity in the basin shows that water productivity of both irrigated crops and rainfed crops varies significantly from region to region. Within the same region, there are substantial differences in economic productivity of water across crops. Among irrigated crops, pulses such as gram and masoor score high. Among rainfed crops, soya-bean has high water productivity. Also, there are remarkable differences in water productivity (both physical and economic) between drought years and normal years for most of the crops, with mostly higher values during normal years.

Green water constitutes a significant chunk of not only total water used, but also the crop economy. Green water use constitutes nearly 61.7 percent of the crop economy in terms of net value product from crop production. But the overall productivity of green water is not very high when compared to blue water. Against a total estimated annual *in situ* soil moisture use of 17.52 BCM, the net value product from crop production is Rs. 18.31 billion. This gives an overall water productivity of Rs. 1.03/m^3 of water, whereas in the case of blue water, the overall water productivity is Rs. 2.5/m^3, with a total annual water use of 4.53 BCM against a net output of Rs. 11.33 billion. However, it needs to be noted that the lack of consideration of probable changes in water productivity values because of changes in sources of irrigation from wells to canals and river lifting would have resulted in some overestimation of the size of water economy.

Since agriculture is the major user of water in the Narmada basin, achieving higher economic efficiency in agriculture is critical to achieving allocation efficiency at the basin level. It could be argued that farmers' decisions are not always governed by technical considerations of water productivity, but by considerations of returns per unit of land, domestic food security, cultural values, and risk coverage. There are no legal limits to the amount of water which farmers can access, both from underground sources and surface systems. However, in reality, farmers' ability to appropriate water from wells and surface schemes would be limited by physical constraints such as absence of good aquifers, problems of groundwater depletion and droughts. Also, land productivity is of lesser concern in the Narmada basin as the cropping intensity is still very low.

Therefore, two questions are worth examining: *First:* whether the natural advantage which certain crops enjoy in certain regions in terms of higher water productivity by virtue of the agro-climate can be made use of, without compromising on farmers' need and priorities. This means, earmarking certain crops only for those regions where they have a relative advantage in terms of higher water productivity. *Second:* whether there is a possibility for adjusting the cropping pattern in a region to allocate more water to crops that are economically more efficient. Another important issue is re-allocating blue water, thereby increasing the effective use of green water to achieve higher water productivity. This is important for crops which give higher water productivity when rainwater and irrigation water are used conjunctively, as demonstrated by our analyses. Farm ponds can be useful for creating storages sufficient for one or two supplementary irrigations. Greater assurance about water availability for kharif production could also result in better use of other agronomic inputs by farmers, resulting in higher water productivity. Such a strategy would especially help during drought years to achieve higher kharif yields and returns.

Finally, the very fact that green water use in the basin is very high, and there are farmers who fully depend on rainfed production emphasizes the need for *in situ* measures for enhanced availability of green water for crop production. The scope for enhancing the effective utilization of rainwater needs to be explored, especially during drought years when the evaporation and ET are generally high. For cotton and paddy sown in the kharif season, delaying sowing time might help increase the effective use of rainwater by synchronizing the crop water demand and rainfall, thereby reducing peak irrigation demands. *In situ* water conservation measures are important for increasing the efficiency of utilization of rainwater, for which field and farm bunds would be useful. Mulching would be useful for reducing evaporation losses from row crops such as cotton. Nutrient management would help reduce drought effects. For irrigated crops, measures to reduce non-beneficial uses such as evaporation component of ET, percolation into sink, crop scheduling to reduce evaporation from fallow land etc. are important.

HEADQUARTERS
127, Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka
Mailing Address : P. O. Box 2075, Colombo, Sri Lanka
Telephone : +94 11 2787404, 2784080
Fax : +94 11 2786854; E mail : iwmi@cgiar.org

REGIONAL OFFICE FOR SOUTH ASIA
C/o ICRISAT, Patancheru 502324
Andhra Pradesh, India
Telephone : +91 40 30713071
Fax : +91 40 30713074; E mail : iwmi-southasia@cgiar.org

NEW DELHI
South Asia Liaison Office
2nd Floor, NASC Complex, DPS Marg
PUSA Campus, New Delhi 110012, India
Telephone : +91 11 25840811-2
Fax : +91 11 25841294; E mail : b.sharma@cgiar.org

NEPAL
Department of Irrigation, Room # 412 and 413
Jawalkhel, Lalitpur
GPO 8975 EPC 416, Kathmandu, Nepal
Telephone : +977 1 5542306
Fax : +977 1 5536219; E mail : d.pant@cgiar.org

CHINA
Center for Chinese Agricultural Policy
Chinese Academy of Sciences
Building 917, Datun Road, Anwai
Beijing 100101, China
Telephone : +86 10 64889440
Fax : +86 10 64856533; E mail : i.makin@cgiar.org

REGIONAL OFFICE FOR CENTRAL ASIA (Pakistan)
12KM, Multan Road, Chowk Thokar Niaz Baig,
Lahore 53700, Pakistan
Telephone : +92 42 5410050-53
Fax : +92 42 5410054; E mail : iwmi-pak@cgiar.org

REGIONAL OFFICE FOR CENTRAL ASIA (Uzbekistan)
Apartment No. 123
Home No. 6, Murtazaeva Street,
Tashkent 700000, Uzbekistan
Telephone : +998 71 1370445
Fax : +998 71 1370317; E mail : m.hassan@cgiar.org

REGIONAL OFFICE FOR SOUTHEAST ASIA
P. O. Box 1025, Kasetsart University,
Bangkok 10903,Thailand
Telephone : +66 2561 4433
Fax : +66 2561 1230; E mail : iwmi-sea@cgiar.org

REGIONAL OFFICE FOR AFRICA
Private Bag X813, Silverton 0127, Pretoria, South Africa
Telephone : +27 12 845 9100
Fax : +27 12 845 9110; E mail : iwmi-africa@cgiar.org

SUB REGIONAL OFFICE FOR WEST AFRICA
IWMI Ghana, PMB CT 112, Cantonments, Accra, Ghana
Telephone : +233 21 784752-4
Fax : + 233 21 784752; E mail : iwmi-ghana@cgiar.org

IWMI-Tata Water Policy Program

The IWMI-Tata Water Policy Program was launched in 2000 with the support of Sir Ratan Tata Trust, Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyse and document relevant water-management approaches and current practices. These practices are assessed and synthesised for maximum policy impact in the series on Water Policy Research Highlights and IWMI-Tata Comments.

The policy program's website promotes the exchange of knowledge on water-resources management, within the research community and between researchers and policy makers in India.

IWMI-Tata Water Policy Program
Elecon, Anand-Sojitra Road
Vallabh Vidyanagar 388120, Gujarat, India
Telephone: +91 2692 229311-13
Fax : +91 2692 229310
E-mail: iwmi-tata@cgiar.org
Website: http://www.iwmi.org/iwmi-tata

IWMI
International
Water Management
Institute

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