

A REVIEW ON MANAGEMENT OF WATER RESOURCES IN SOUTH AFRICA

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Abstract

Globally water is a vital need. South Africa is getting quite less amount of rainfall (500 mm) in comparison to the global average (860 mm). This low rainfall coupled with wide variability in rainfall across wet eastern and dry western regions poses great challenges. This calls for integrated water resources management which encompasses synchronized expansion as well as management of not just water but also land and aquatic ecosystems. Besides water scarcity, a number of other hurdles exist including frequent droughts, flooding, salinity, illegal water abstraction and water allocation. Further, surface groundwater aquifers limit the full exploitation potential of groundwater resources. Pollution of groundwater is a challenge since groundwater is the most economical water resource for most small towns and rural villages. Based on the provisions of the National Water Act, 1997 of South Africa, a National Water Resources Strategy was developed but not able to resolve the issues. In this review, the different components of water resources management, in context to South Africa are discussed. Different categories of water usage spanning domestic, industrial, mining, hydropower and irrigation have been included. The overall ecological and environmental balance for ultimately sustaining has also been discussed.

Keywords: *Water scarce; Climate change; Pollution of groundwater; National Water Act; South Africa*

Introduction

Water, despite being the omnipresent component, its availability, quantity as well as quality is always debatable [1]. On the global platform, water scarcity and management continue to daunt the world. The water scarcity has led to a political conflict within the states of a country as well as within the neighboring countries if the source of water flows trans-boundary. The issue is above political boundaries and legal generalization. Water scarcity arises due to several issues primarily: constraints of physical resources as well as inadequate rainfall, ever-increasing demand due to population explosion and stagnant economies. In this context, Schmidt [2] raises the issue of the security of water. He considered political, techno-institutional and conceptual aspects of water, and suggested that water though once abundant, has now become scarce, and this mismanaging scarcity may yield in security issues [2]. This calls for apt conservation and management of water resources.

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Globalization trends with respect to developmental areas such as communications, agriculture, energy, mining, and transportation and, social ones like environment, education, health, rural and regional areas have drastically fueled the demand for water resources [1]. Moreover, population growth is the reason for increased water demands. Furthermore, groundwater levels are getting rapidly depleted; while surface water supplies are being increasingly contaminated. Also, the cost of maintaining a smooth water supply is huge. In a report from World Bank, an estimation of \$600 million dollars was done for improvement and repair of existing water delivery systems (of the country, continent or globe) [3]. In addition to these concerns, the water allocation process being physically complex and intrinsically a game of political turmoil and power further complicates the usage pattern [4]. Several studies in the African countries have indicated that priority usage and users have been classified based on economic and administrative credentials affecting the lives and livelihoods of truly needy local communities [5].

In order to overcome water related problems, various aspects need to be taken into consideration: processes of water management; the capabilities and competence of both government and private institutions; social political impact; the practices and processes of management and development; management of supply, implementation status and appropriateness of legal frameworks the existed; investment funds availability; environmental and social conditions of the area concerned; the usable technologies present; perceptions at local, nationwide, and worldwide levels; governance modes that include issues such as transparency, political interferences, corruption, etc.; research quality and its relevance on local, sub-national and national water problems [1,6].

Status of Water Resources in South Africa

South Africa experiences irregular and seasonal rainfall, almost half of the world's average. 21% of the nation receives less than 200 mm rainfall while 65% receives less than 500 mm. Most of the parts of the country are arid to semi-arid (Fig. 1).

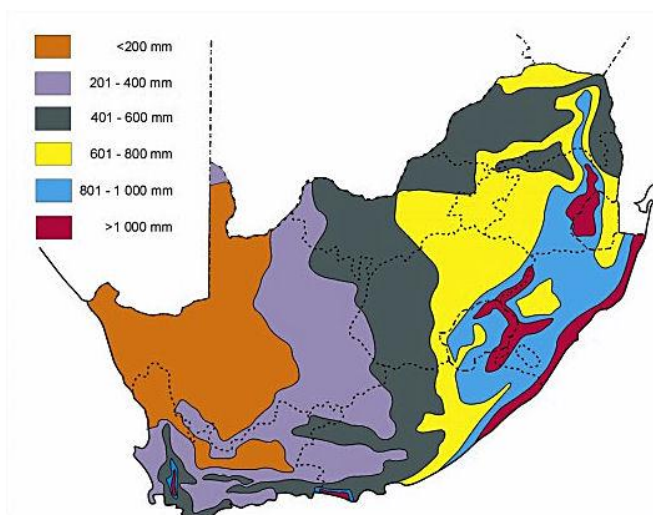


Fig. 1. Mean Annual Rainfall in South Africa [7]

The water resources of SA consist of three resources ground water, surface water and return flows. The major of the actives like urban, industrial and irrigation of South Africa is dependent on surface water resources that comprise approximately 78% of total water resources. The main rivers are the Orange, Limpopo, Incomati, Maputo, Tugela, Olifants and Breede. Some of the river basins are also shared by neighboring countries. Only 12 km³/year of

surface water is estimated to be utilized as most of the water is lost through flood spillage (Fig. 2) [8].

The ground water usage is limited due to the hard rock geology type of the region. The places having aquifers and rural and arid extensively utilize ground water. Approximately, 1 km³/ year is the availability of ground water for general usage (Fig. 2) [8].

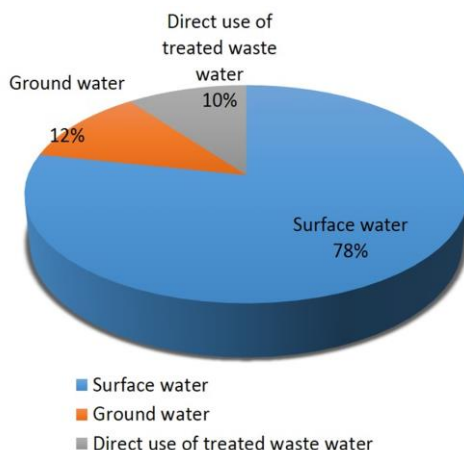


Fig. 2. Water use from different sources (the figures are in percentage).

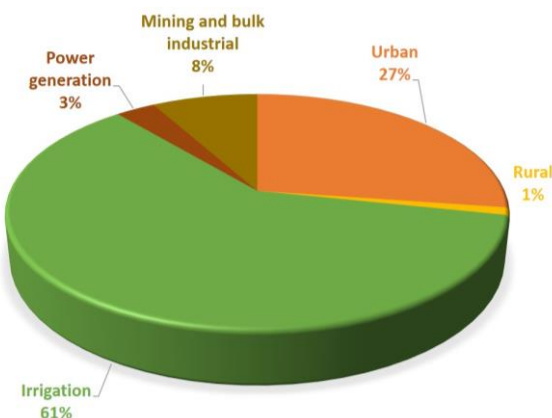


Fig. 3. Water requirement per sector presented in percentage out of the total requirement of 15527 million m³ [8].

Water use demands and requirements

Around 60% of total water is consumed for agriculture, 27% for urban requirements and the remaining 13% for other requirements (Fig. 3, Table 1) [8]. According to the estimates, by 2050, the population is predicted to reach 53 million and thus, there will be an upsurge in water demands.

Table 1. Water requirement per sector (million m³) [8]

Sector	Water requirement (million m ³)
Irrigation	9300
Urban	4185
Rural	210

Mining & Bulk Industrial	1167
Power Generation	485
Afforestation	180
Total	15527

To utilize water resources, dams have been constructed timely to meet the water requirements. Fig. 4 shows the number of dams completed in each decade. The biggest dam among all is the Gariep Dam having a capacity of 5.5 million cubic meter [8].

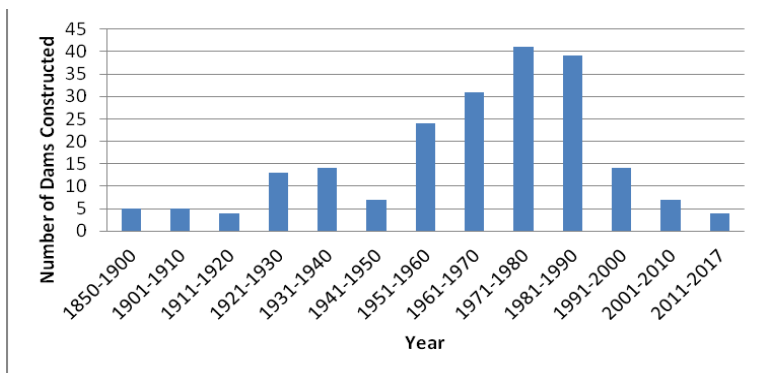


Fig. 4. The number of dams constructed in different decades in South Africa [8].

Water Management in South Africa: The Challenges

Historically, South Africa has been established as a country with limited water and on the order of thirty among the driest countries [9] and considerable measures have been undertaken to store water in order to cope with recurrent droughts in the country. The racial policies of societal segregation in the Apartheid regime (1948–1994) reflected the water access in South Africa, the economic and political context and further altering water policy in South Africa post, 1994 [10]. As a result, water access was highly unequal dominated by race, gender, and class. A dramatic and drastic paradigm towards the water sector was observed in 1994 with political democratic turmoil in the post-apartheid South African government. With the motto 'some water for all forever', there was a practice of greater equity and satisfactory access to water, particularly for the black people. A better understanding of the country’s situation along with success stories of management of water resources from other countries geared up South Africa for the much-awaited water reform. The flagship law, the National Water Act [11] was passed by the African National Congress (ANC) [12]. The Dublin Declaration principles and Integrated Water Resource Management (IWRM) were the key driving force behind this [13, 14]. They led to the establishment of demand-driven water management policy, which was eventually protected in the NWA. The radical water enactment endorsed value, representatively, manageability and effectiveness through water administration reorganization, new regional and local foundations, water clients' enlistment and authorizing, and the development of water rights' business sectors [15, 16]. The law firmly depended on the way that water must be ensured for all, particularly to meet the fundamental needs of needy individuals from rustic foundation who have languished over so long. Moreover, water can't be essentially designated to take care of the expanded demand from farming, industry or some other alleged "beneficial divisions" yet should likewise point towards an adjust by fulfilling the prerequisites of amphibian biological systems and the natural hold. Another critical angle is the catchment administration organizations (CMSs) wherein the water assignments will be decentralized. Furthermore, in states of water pressure, approvals for water deliberations are foreseen with mandatory authorizing [16].

Water resource-scarce and unevenly distributed

The low average annual rainfall of roughly 464 mm compared with the world average of 860 mm. The situation becomes worse owing to low mean annual precipitation resulting in a meagre (8.6%) runoff conversion to useable forms, which accounts for the lowest proportion in the world. Due to climatic and geographical variations in South Africa, the availability of water is also affected in terms of both quality and quantity due to rainfall seasonality and uneven spatial distribution (about 13% land receives 43% of total rainfall). The low stream flow in rivers restricts the proportion of stream flow that can be exploited profitably. As far as semi-arid South Africa is concerned, water is categorized as a rare commodity. Moreover, environments related to vast waterways are horrible in contrast with terrestrial ecosystems. Of 112 river ecosystems evaluated, 12% were vulnerable, 18% endangered, 54% fundamentally jeopardized, 84% were threatened [17]. This alarming pattern indicates the growing risk of water shortage in order to meet social, economic and environmental requirements in the coming time.

The current situation is also miserable especially in the rural and suburban black areas, where about 14 million people still at present don't have access to running water in their houses [18]. Country ladies need to make a long-distance journey to gather residential water from waterways or water focuses. This has caused severe food insecurity at the level of household and environmental degradation of huge proportions [18]. This issue is relied upon to be exacerbated by statistic changes, urbanization and developing white-collar class society, with higher water, nourishment and power demands. Area of major urban and mechanical advancements also strains the water availability and transfer. Socio political manipulation further aggravates its scarcity. These exponentially growing challenges, therefore, necessitate the management of water resources for food and ecological security.

Climate change: Impact on water accessibility

The water accessibility for consumable water, sanitation and for water system is as of now a significant issue in fulfilling the nation's demand and will turn out to be more as populace development and environmental changes compound existing stress for water. Most of the sub-Saharan African countries are abundant in environmental and natural resources. However, financial turbulence, natural calamities and climate variation severely impact energy consumption, growth, and foreign trade in Sub-Sahara African countries [19]. Amongst the energy, food, water, and environmental sustainability nexus, the water resources availability are anticipated to be affected the most by climate change. This in sync with ever-increasing population and accordingly demand for primarily potable and irrigation water, and that for sanitation is a serious threat in developing countries [20].

Studies have demonstrated that initial warming will impact water assets and as an outcomes water shortage is probable to end up a consistently expanding issue later for different reasons. To begin with, the appropriation of precipitation in space and time is extremely uneven, prompting gigantic fluctuation in water assets around the world [21]. For instance, the driest place on earth, the Atacama Desert in Chile gets extremely slight yearly amounts of precipitation every year while then again; Mawsynram, Assam, India gets more than 450 crawls of precipitation every year. On the off chance that all the fresh water on the planet was isolated similarly among the worldwide populace, there would be 5,000 to 6,000 m³ of water accessible for everybody, consistently [22]. Secondly, the rate of evaporation fluctuates relying upon the temperature and relative humidity that affect the amount of water accessible to renew groundwater potential. However more serious precipitation in addition to expand evapotranspiration and expand water system is relied upon to prompt groundwater consumption [23]. The warmer temperature will accelerate hydrological cycles modifying precipitation, size and timing of overflow as well as the force and recurrence of flood and dry seasons. The rising temperature will expand the rate of evapotranspiration and adjust soil moisture [24, 25].

The climate change influences in terms of extreme weather events like downpour to many locations and scanty of rainfall to many other locations are resulting into flood and drought respectively. This creates the degradation of water quality to flooding sites and scarcity of water to the drought site. Further, well reported sea level rise due to changing climate has started contaminating the coastal aquifers by the intrusion of salinity into the freshwater aquifers. The higher temperature and humidity can create a favorable condition for many diseases especially the waterborne. The increasing activities of the storms are the concern of damaging the infrastructures including the health care facilities and forcing people to migrate for their shelter and livelihood or the government must take care of their resettlement and rehabilitation latter on.

On the other hand, droughts can also substantially affect quantity and quality of available water resources. Apart from climatic conditions, improper allocation and usage also bring about severe constrains. The time span of years 2016-2018 is recognized as drought-ridden in RSA with immense implication:

- Agricultural producers are particularly vulnerable as rain-fed production gets affected.
- Water supply to urban areas for domestic, industrial and agricultural purposes also gets affected.

Poverty- the legacy of apartheid discrimination policies

There is persistent chronic poverty in large parts of South Africa, characterised by a dearth of employment opportunities, low levels of economic activity, and subsequently huge dependency on welfare. Despite several reforms since the new government in power, the basic issue of racial groupings and likewise reservation still exists affecting the maximal population, especially the rural as tabulated in Table 2.

The rural population of South Africa comprises 1.5 million families sustaining on commercial farms (mainly white) and 2.3 million families are surviving in the former homelands [15]. Poverty rates are high considering more than 50% of the total population residing in rural areas. Most of these people do not have proper housing, sanitation, and even access to potable water. Though there are extensive welfare programmes for the rural population, the situation is still bleak as wages hardly contribute to the income of such families. In 2006-07, only 16% of the active rural population (aged between 15-64 years) were employed. The situation worsened with the crippling 2008-09 global recessions, further hitting the poor and marginalized [26]. Over the last decade, migration from rural to the urban areas as well as remittance from the urban to the rural has significantly declined, further widening the rift between these sectors. Even within the rural population, poverty has been shown to be governed by the race and head of the family (households headed by women are poorer than those by men) [15].

Table 2. Racial grouping in relation to the population [27]

Groups	Poor individual share (%)	Individual poverty rate (%)	Population (%)
All	100	47.1	100
Coloured	6.3	34.2	8.9
Indians	0.4	7.1	2.6
Whites	0.1	0.4	10.9
Blacks	93.3	54.8	76.7

Even the contribution of otherwise well-established agricultural practices in rural economy has been severely affected. For example, crop and livestock production yields only 1% and 4% of rural household’s income respectively in Bantustans. Several studies suggest growing food insecurity in such a background. Furthermore, agriculture contributes towards a

much lower part of GDP contrasted with other lower middle-income nations of a similar class. Despite well-performing business area, agribusiness characterizes to be under 4% of GDP and 14% of the work force [15]. Politically sanctioned racial segregation included motivators, laws and foundations that support extensive homesteads and oppressed littler, work escalated cultivating frameworks [15]. These figures are disturbing considering that watered agribusiness and stock watering represent around 52% of aggregate water utilization. These parameters indicate towards broader concerns of education, health, service and infrastructure for apt utilization of natural resources and diminishing the huge gap between the poor and the rest of the population.

Water use among racial groups

Water shortage is becoming an alarming concern globally. With time, increasing population and multiple water associated demands will further pressurize the existing global water resources. It is estimated that by 2025, approximately 230 million people will be living in countries facing water scarcity like South Africa [28]. The situation will be grave considering the limited water resources availability in future and increasing population will raise the demand of water in comparison to the present status of per capita for local purposes. In South Africa, there is a huge disparity in water allocations and use among various groups. The usage has been Blacks being the dominant population in South Africa, account for 76 of the entire population. However, 54.8% of these individuals live under extremely miserable conditions, including access to potable water [27]. In contrast, White individuals are far better off, with only 0.4% under poverty, nevertheless, having accessibility of potable water. The Indians are least populated accounting for only 2.5% of the entire population [27]. Poverty issues are minimal for them too.

Water allocation and usage in South Africa

Conventionally, water allocations in South Africa’s Inkomati, Jan Dissels and Mhlatuse River basins were managed by a few institutions making the process complex and largely biased. The “National Water Act of 1997” and subsequently, the “Water Allocation Reform Project” redefined the allocation system, aiming towards equity of water allocation. These are primarily based on the following features [29] (Fig.5).

- Ground water and surface water is publicly owned
- Irrigation is the chief water acquiring area
- At the current pace and requisite, water resources are considered overused, and counter measures need to be taken to reduce water usage at critical times.

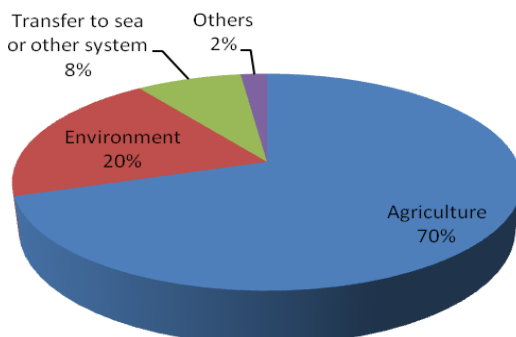


Fig. 5. Allocation of water resources in various sectors [29]

In contrast, high revenue suburbs of South African cities are dominated by white races, and a large percentage of water is being used for recreation purposes, up to 50% for horticultural purposes, while only 2% for cooking and drinking [29]. Henceforth, there still exists a huge disparity in equilibria of access to the capitals and implementation of new

schemes of water resource management may attest useful in connecting the gap. The “National Water Act (RSA, 1998)” [11] and subsequently the “National Water Resources Strategy (NWRS)” have been formulated for the same. The NWA specifies that justice, sustainability and efficacy were the guidelines for water resources administration in South Africa. But, equity remained a concern. Water Allocation Reform (WAR) was then introduced to address the inequity. It serves as the strategic link between policy intention and the actual implementation of the guidelines. A great weightage was given to Blacks, especially the women under this. As per WAR, 60% of accessible water should be under control of black people, while half of this under the control of black women. WAR constitutes of review and integration of the institutional arrangement, and development and implementation of the “water allocation action plans” and intends to achieve its goal by 2024. If implemented likewise, the Water Allocation Reform Strategy will have immense implication [30].

Environmental aspect

The apartheid government relied on the concept of economic good for water usage. However, with the time the understanding of Environment as the water user emerged. The highest priority is given to the water that designated for basic human needs and for the environment, often referred to as ‘reserve’ in the “National Water Act”. According to the commission 1970, an arrangement should be made for the sensible needs of nature preservation areas. It would be lamentable both for nature protection and for our visitor industry if too little water were to be accessible for wildlife in the Kruger Park. Other nature protection zones, for example, the St. Lucia Lake, require fresh water for the protection of natural resources [31]. The commission estimated the environmental share at 1% of total water usage. However, with time it was realized that it accounts for only a small part of actual requisite. In view of this, the DWA [7] estimated 13% of total water demand for lakes, estuaries, riverine habitat, wetlands, and conserved areas. Past this, water ought to be dispensed by authorities from river basins to guarantee that the best general social and financial advantages are accomplished [7].

Water Sector Framework

Institutional framework

Resource management is of utmost concern in South Africa, which has a dearth of water. Management reflects a range of practices to achieve a balance between needs and interests of water usage at par with available resources [33-34]. In this direction, institutional arrangements, both from public and private sectors are actively working towards water management in South Africa, redefining existing roles and introducing new ones [34-36]. This will overall contribute towards apt utilization of limited water resources and overall in alleviating poverty and economic development in South Africa [35, 37].

a) The Department of Water Affairs and Forestry

This department is considered as the national custodian of water and forestry resources of South Africa. The department is further accountable for the formulation and implementation as well as regulation of policy for these sectors. In addition, the department ensures the provision of water services by the local government, bulk water supply, and operation of water resources and retail infrastructure. The prime objectives with respect to Water Resource Management and service are as follows:

Management:

- Establishment of a National Water Utility and implementation of the provisions of the National Water Act
- Establishment of the “National Water Resource Strategy” and “Catchment Management Strategies”

- Establishment and empowerment of “water management institutions”
- Development and implementation of water pricing strategy, resource protection, licensing, conservation, demand management
- Development and implementation of resource monitoring coordination structure, and information systems

Services:

- Imperatively, provision for basic water need – potable water and for sanitation.
- Monitoring of services institutions and water boards, including local authorities
- Development and establishment of services monitoring and information systems, in order to attain sustainability, effectiveness, efficiency and affordability of the services provided.

The Directorate aspires to achieve excellence and innovation in integrated water resources management and equitable allocation and apt usage and of water resources, ultimately in the public interest. This Directorate aims to promote “integrated sustainable utilization”, protection and management of the quantity and quality of water resources. This is accomplished by the following means:

- Development and establishment of policies, strategies and regulations
- Integration of WC / DM into all relevant departmental functions
- Impartment of awareness and education
- Provision of support to water services institutions, while simultaneously monitoring and evaluating them
- Development of sectoral WC / DM strategies including commercial sectors like mining, power and industry, and others like agriculture and forestry.

b) Water management institutions

The South Africa’s National Government is eventually accountable for guaranteeing that water resources are utilised, managed, regulated, conserved, and protected in a sustainable and equitable manner benefiting one and all under the consideration of the environmental aspects. The following institutions have been delegated to achieve smooth and coordinated functioning to achieve the prime goal (Fig. 6):

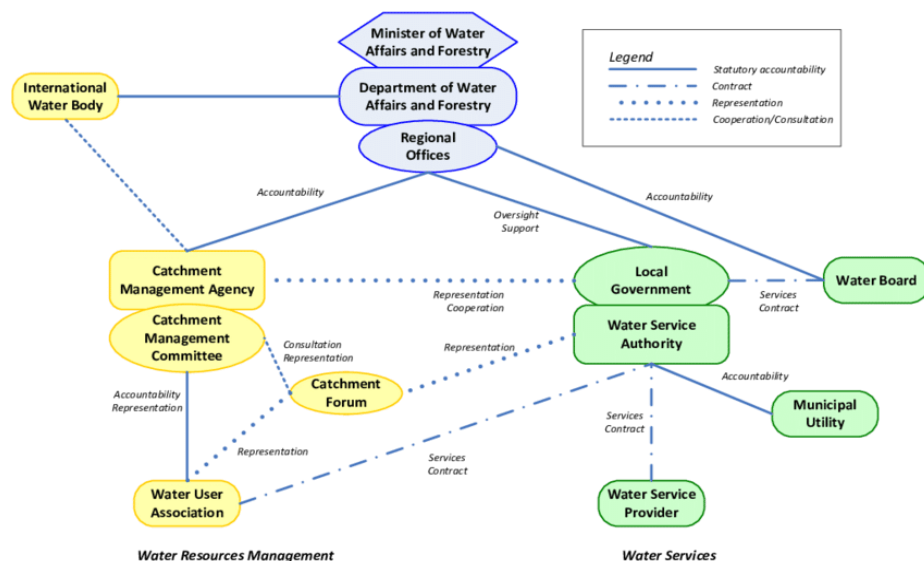


Fig. 6. Hierarchy of Water Management Institutions [38]***Catchment Management Agency (CMA)***

The prime function of CMA is to be responsible of water resource management to a regional catchment level by also involving the local communities in the progression. The country has 19 Water Management Areas (WMA) where each of these should have its own CMA. The CMAs are responsible for use, development, management, control, conservation and protection in their respective WMAs. They do so by devising suitable catchment strategy, implementation of such plan, promotion of community participation, and coordination of waters users and management institutions

Water User Association (WUA)

They represent cooperative associations of individual water users who undertake such work for mutual and societal benefit. These are operated at a level, ensuring the proper distribution of local water resources. They are typically involved in small scale agricultural, domestic water supply, bulk municipal and likewise activities.

International water management bodies

They refer to international, nonprofit, research organizations that actively work on managing and improving resources in water scarce countries especially across Africa and Asia. Their eventual mission is to reduce poverty, ensure food security while safeguarding environmental concern. Some people at the individualistic level take up the role of management of water resources, ensuring implementation of the catchment management strategy within a particular area and safeguarding public interest.

c) Water services institutions (WSI)

The Water Services Act functions through four different water services institutions:

Water Services Authority

The authority refers to a municipality which is responsible for ensuring access to water supply and sanitation services. The authority may function directly or in conjunction with other Water Services Providers (WSPs).

Water Services Provider

They are responsible for physically providing water supply and sanitation services. In addition to WSA, they also undertake such work along with water board, nongovernmental organization, community-based organization, companies, or any other private or public organizations.

Water Board

The water board, established by the ministry of "Water Affairs & Forestry", is a public water services provider. Its principal responsibility is to deliver water services to other WSIs. The board also undertakes management services, training and other support services

Water Services Committee

It refers to the statutory committee, which is established when the functioning of WSA is compromised.

Legislative framework

In South Africa, water legislation largely drew from old standing traditions conduct and racial segregation policies. The post-apartheid water reforms were intended to redress these disparities between black and white societies in order to water accessibility in sustainable manner and satisfactory distribution [39-40]. Accordingly, South Africa has adopted a progressive law and policy framework for equitable water accessibility for all. Water legislation is not the eventual solution but instrumental in enforcing and regulating the water policies [35]. Accordingly, legislation that is not headed by, or does not clearly involve the adoption of

certain policies, is unlikely to meet its true purpose [41]. Though policies have been developed for apt usage and distribution of water resources in South Africa, their implantation remains questionable even after decades of their formulation. This is largely a legacy of the apartheid regime but also derives from economic political approach to water policy. With insights into ecological integrity, concerns for the same are also growing exponentially. Henceforth, integrative, flexible and dynamic policy and legislation were truly called for.

The first Water Supply and Sanitation White Paper, the White Paper (1994) concentrated on the formation of a new national department of water. It aimed at the provision of elementary water and sanitation amenities to people inhabiting rural areas. Since 1994, the water sector and related legislation and policies have undergone remarkable transformations, with respect to increasing concerns on available water resources as well as advancements in institutional and financial frameworks.

The White Paper on “National Water Policy” [42] gave new integrated policy positions for protection, use, development, conservation, management and control of water resources of South Africa. The South African National Water Act (Act 36) introduced in the year 1998, was a major progressive step in this direction. It served as the steppingstone for merging integrated water resources management (IWRM) into legislation [43]. This Act along with the Environment Management Act (Act No. 107 of 1998) established the environment as the top priority water user laying great emphasis on ecological aspects. The law requires that ecological flows be released from dam reservoirs to meet the requirements of both the river and estuary.

Subsequently, the Municipal Systems Act (Act 32 of 2000) was introduced which concentrated on internal systems and administration of a municipality for smooth functioning. The Act was dynamic to take into account of involving people and fixing responsibility while making a policy. A clear distinction between services authority and services provider was made as per the Water Services Act. Several new institutional entities were also introduced.

This was further redefined with the New White Paper on Water Services (2002), which sets out a detailed policy tactic in relation to the entire water services sector in South Africa. The policy spread over small community water supply and sanitation schemes to inaccessible provincial zones. In South Africa, water enactment has been reclassified in view of specific dangers, group clashes or particular uses through the accompanying checkpoints:

- Risk emerging from the present utilization of water (regulations on natural runoff of rainwater, flood control, and construction of wells)
- Specific usages of water (laws on the supply of consumable water, river navigation, irrigation, industry, energy, fish breeding)
- Multiple usages of water and its conservation (range of applications of water and their coordination)
- Joint administration of various natural resources (regulation aspects for association of water on other characteristic assets)
- Environmental consideration.

Improvement of Water Resources Management in South Africa

The Water Resources Group (WRG), built up in 2008 by a consortium of business accomplices to contribute new bits of knowledge about the ever basic issue of water asset shortage, the assessed interest for water in South Africa will achieve 17.7 billion cubic meters in 2030. In correlation, present supply will add up to just 15 billion cubic meters and is intensely controlled by low levels of prooundly regular precipitation estimated at half of the worldwide median, a deficient number of aquifers, and a dependence on water exchanges amongst basins and from different nations a prime illustration is the Lesotho Highlands Water Project, from which South Africa buys around 25% of its aggregate water supply [45] (Fig.7).

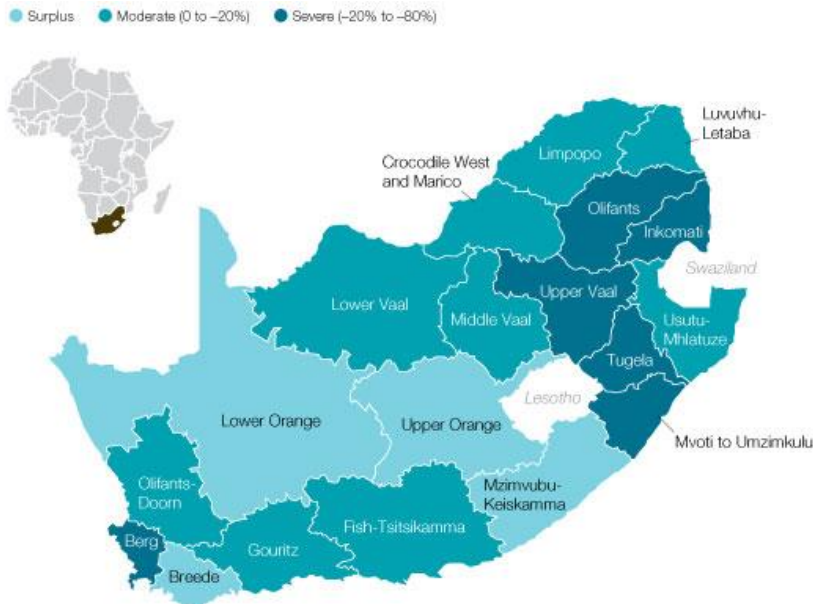


Fig.7. Gap between existing supply and projected demand in 2030 [44,45]

Implementation of new strategies

Water shortage has turned into a noteworthy risk to human prosperity and a peril of the water shortage and its unequal accessibility is a matter of concern that may lead to the conflict in the society for having control on the available water [46]. While freshwater supplies are explicitly constrained and the shortage may cause the rivalry between water users and political, and monetary boundaries that limit their accessibility to water [47].

The genuine imbalance in access to and control over water and the contentions between the diverse uses and clients of water lie at the core of the requirement for new ways to deal with water administration. This necessity is generally perceived just like the conviction that current institutional arrangements for water administration are improper and a noteworthy constraint for accomplishing economical water management. For better economical water administration, most experts prescribe overseeing water in view of basins of the river and expanding partner interest in water administration [48]. In South Africa, poor individuals are commonly denied the advantages of water. They are the main individuals who experience the ill effects of perilous water shortage. These individuals are more prone to hardships. Poverty, characterized as a state and procedure of multidimensional hardship influencing monetary, wellbeing related, mental, socio social, legitimate, and political features of prosperity [49] is manifested in social advancement and administration of water assets in the following process:

- i) The needy individuals do not have the technological resources to get water.
- ii) The absence of proficient access to accessible water assets has led to rely on the low quality water against excessive hard work or money costs, particularly during dry spell.
- iii) This also require the judicious use of water in agricultural sector where it is consumed more.

Ineffectual water strategies and water infrastructures genuinely disturb social orders and in addition the local environment. The operative and adequate administration of water scarce capitals in South Africa, the following accompanying approaches need to be implemented:

i) Legislation arranged to specific usages of water (including the legislative control on the supply of consumable water, water system, waterway navigation, vitality, industrial use, and fisheries).

ii) Legislation for different employments of water and its preservation as an asset.

iii) Legislation for the joint administration (open, private, partners) of water utilization. This becomes difficult to manage in a water scarce country like South Africa, where the farming and cultivation appear as the need with the popularity of water use be restricted for the direct human need.

iv) The association of groups amid policy making can help by considering the genuine requests (particularly the nuts and bolts) that the groups require. Moreover, enabling the groups towards conservation and management would be helpful in diminishing mismanagement or abuse of characteristic assets (water).

Financial administration

Legislative control influences the best possible administration of water assets because of verbal confrontations on water allotment to the people. The reality is that the poor people don't have much benefit as far as access to natural resources is concerned, for example, water because of political activities. There is an auxiliary gathering called water allocation monitoring index in South Africa doled out by the Department of Water Affairs. The primary part of this gathering is to guarantee that each South African people will have accessibility to potable water. In practice this is not existing, since a few if not most "especially poorer" are deprived to equal access of potable water. The association amongst financial aspects and the environment through foundations is essential to asset and ecological financial matters in light of the fact that in managing the foundation of monetary establishments, governments or other capable offices certainly guide conduct concerning asset utilization [35, 50]. In this manner, the efforts of sustainable advancements and the protection of natural capital ought to give an unequivocal treatment of financial foundations and their part in making the vital motivating forces to accomplish these goals [34, 51]. The plan and working of foundations will in this manner decide the way in which assets are assigned and how the pay determined through asset management is dispersed. The opportunity and transaction expenses of institutional changes are not static but rather persistent because of the impacts of institutional interlinkages and the effect of changes both in the endogenous (racial gatherings, legislative issues, population growth, economy) and exogenous elements (effect of environmental alteration on water accessibility) [51]. Since the greatness of net advantages from institutional changes is an immediate water shortage, the monetary desire for institutional change increments with each expansion in a water shortage. In this way, as water shortage ends up intense because of monetary improvement or population growth, the genuine financial expenses of unsuitable water establishments tend to rise [35].

Integrated Water Resource Management (IWRM): a radical approach towards water turmoil

Contemporary global water discourses have correlated "water security issues" with the "crisis of governance" (UNESCO, 2006: 1). Accordingly, international organizations have increasingly promoted institutional models that support 'good governance' in developing countries to address such concerns for a crisis. In the water sector, the concept of good governance has been equated with integrated water resources management (IWRM) [52-53], which is gaining popularity worldwide [54]. Integrated Water Resource Management is also stated as the Dublin-Rio principle as it was developed at the Dublin conference 2 [55]. Even if the pertinence of IWRM as a universal model for water governance has been increasingly

questioned, it still remains one of the most fundamental and prominent governance models in the water policy sphere [56]. The key features of integration, decentralisation, river basin planning and participation have been centralized to achieve the aim of IWRM [57]. Dominant and mainstream global water discourses support this practice and believe that it will lead to economically efficient, equitable and sustainable water management [58].

IWRM has been defined and modified differentially by a number of scholars, which allows us to focus on various water management practices [59]. According to GWP, it is a procedure that advances the planned development and administration of land, water, and related assets, keeping in mind the end goal to augment the resultant monetary and social welfare in an impartial asset, so as to amplify the resultant financial and social welfare in an equitable way without compromising the maintainability of essential vital system [58]. IWRM isn't an objective, yet a nonstop procedure to adjust and make tradeoffs between various objectives and perspectives in an informed way [60]. IWRM can likewise be basically characterized as a process that empowers the organized administration of land, water, and related assets within the limits of the basin [61].

With expanding mindfulness at the worldwide stage, the significance of water assets at the national, territorial and nearby levels is picking up recognition [61]. The usage of IWRM honours can't be isolated from national methodologies and strategies connecting different levels of government and private division [62]. IWRM requires a reasonable system where the parts and duties of partners concerned are characterized [61]. Besides, the fruitful execution of IWRM is reliant on powerful water administration. Water administration ought to be supported by political will, regulations, policies, controls, financing establishments and other organizations to manage assets. IWRM guarantees that every single intrigued partner is included [59, 61]. However, with increasing gaps in achieving the ultimate goal, a number of scholars have questioned their conceptual underpinning, universal character and practical applicability [63-64]. This paved the way towards Developmental Water Management.

Developmental Water Management (DWM): the paradigm shift

The Department of Water Affairs of South Africa issued its Second "National Water Resource Strategy (NWRS2)" in the year 2013. As opposed to the first, which had "integrated water resource management (IWRM)" as the larger objective, this rendition presented the idea of developmental water management (DWM), inserted in the law based formative state. As per the NWRS2, formative water administration still reflects and expands upon the [IWRM] standards of value, environmental sustainability and proficiency that support the National Water Policy and National Water Act. Further, the following two decades of endeavours to execute IWRM, more interpretation and solid direction were required. Within IWRM it is important to painstakingly interpret these standards inside the context of a formative state, so DWM can be considered a piece of IWRM rule in practice [65].

The NWRS2 veers from the crucial IWRM in the accompanying parameters [10]:

➤ NWRS2 water administration isn't the end of this technique. The political idea of water administration is perceived by expressly rendering water administration subject to the objectives of South Africa's democratic state of redistributive, equitable, and expansive based social and monetary advancement. It likewise lines up with the administration's general sense of duty regarding the limit of superfluous financial expenses, including pointless regulatory necessities and deferrals.

➤ It underlines upon the basic rights, setting water framework and service delivery in the middle of everyone's attention. It points to not just the continued development, activity and upkeep of water framework that can be self-financed, yet in addition the arrangement of

subsidized foundation to help destitution destruction and the financial improvement of poor groups as a component of a more extensive, irrigation driven agrarian change.

➤ Most significantly, equity is operationalized. It reaches out to the movement that water assets must be detracted from usages that are less impartial and make less employment.

Henceforth, to make a harmony amongst value and monetary effectiveness; the NWRS2 sets the accompanying request of needs in water portion [10-16]:

- Ecological and fundamental human stores
- International commitments
- Water for destitution annihilation and reviewing imbalances from the past;
- Water usages that are deliberately essential
- Licensed water for general monetary purposes

Conclusions

Water is the essential component of life, without water numerous lives are being undermined. There are numerous difficulties with respect to water administration in South Africa. This is principally due to lacking precipitation, henceforth mishandling of water assets because of political breakdowns and racial gatherings likewise add to the issue. A portion of the difficulties may include restricted physical assets, a fast-developing populace, and dormant economies. Complex difficulties direct a basic need to oversee and preserve water assets legitimately. A considerable measure still should be done as far as execution of new techniques to battle a portion of the difficulties contrarily influencing proper water assets administration in South Africa. Likewise, enactments on water access and usage should be reconsidered satisfactorily to oblige each South African regardless of race, economic status and literacy. The “water allocation monitoring index” in South Africa could assume an indispensable part by advancing projects that will guarantee all South African gain admittance to residential and drinking water. In any case, this gathering sees non-functioning and political exercises. Following two decades of intense experimentation, equity has been progressively embedded in South Africa’s water strategies, in ways that are likewise applicable at other places and that address the developing assessment that the equity column misses out in IWRM. The DWA has turned out to be responsible for political points that explain the crossing points between financial productivity and equity. Due to this, the era of good times ended for three disconnected principles that could legitimize any for the sake of IWRM, including the propagation of the inheritance of the two pre 1994 standards. Further, the new objectives underline joint effort with other state organizations, overcoming past detachment. Looking back to the nuts and bolts of water administration, open and private interests in the foundation are recovering their focal place on the agenda, now specifically including the legitimate needs of the poor which would be overlooked without a democratic and law-based advancement state. Water usage approval is probably going to be streamlined and better focused on, while assisting poor people. The place where all water assets have been assigned, the DWA takes expanding forces to reallocate to the utilizations with the most noteworthy value results, without endangering ecological maintainability. In other African nations, such clashes can be evaded by guaranteeing investments in the foundation from the early times of water development onwards. It isn’t projected that formative water administration will suddenly scaffold the profound partitions and political contestation over water in South Africa, yet it seems to give a more thorough and formative premise than IWRM. The DWA perceives that water assumes an ideal part of poverty annihilation, the decrease of imbalance, comprehensive development and

advancement, and building a fair and impartial society. The mediations sketched out in the new national water assets technique and the national framework design will add to satisfying South Africa's financial advancement potential. At the core of these mediations are sound and effective water assets planning and administration being incorporated into local, national and provincial planning and therapeutic activity forms. At last, this will build up the basic economical water production network, from source to tap to a source, that is expected to guarantee South Africa's present and future water needs are met.

References

- [1] A.K. Biswas, *Integrated water resources management: a reassessment: a water forum contribution*. **Water international**, **29**(2), 2004, pp 248-256.
- [2] J. Williams, *Water: Abundance, scarcity and security in the age of humanity*, **Water Alternatives - An Interdisciplinary Journal on Water Politics and Development**, **10**(3), Special Issue, 2017, pp. 934-936
- [3] I.P. Molobela, P. Sinha, *Management of water resources in South Africa: A review*. **African Journal of Environmental Science and Technology**, **5**(12), 2011, pp. 993-1002.
- [4] A. van Eeden, L. Mehta, B. van Koppen, *Whose waters? Large scale agricultural development and water grabbing in the Wami-Ruvu River Basin, Tanzania*. **Water Alternatives**, **9**(3), 2016, pp. 608-626.
- [5] J. Cullis, B. Van Koppen, *Applying the Gini coefficient to measure inequality of water use in the Olifants River water management area*, **Research Report 113**, International Water Management Institute, Sri Lanka, 2007, ISSN 1026-0862, ISBN 978-92-9090-665-0
- [6] J.L. Ivey, J. Smithers, R.C. de Loe, R.D. Kreuzwiser, R.D. 2004. *Community Capacity for Adaptation to Climate-Induced Water Shortages: Linking Institutional Complexity and Local Actors*. **Environmental Management**, **32**(1), 2004, pp. 36-47.
- [7] * * *, **Management of the Water Resources of the Republic of South Africa**, Department of Water Affairs, 1986.
- [8] * * *, Food and Agriculture Organization of the United Nation, AQUASTAT website, www.fao.org/nr/water/aquastat/main/index.stm (accessed on 1 June 2018)
- [9] * * *, EyeWitness News 2017, <http://ewn.co.za/2017/11/28/sa-ranked-30th-driest-country-in-the-world> (accessed on 1 June 2018)
- [10] B. van Koppen, B. Schreiner, *Moving beyond integrated water resource management: developmental water management in South Africa*. **International Journal of Water Resources Development**, **30**(3), 2014, pp. 543-558.
- [11] * * *, *National Water Act, 1998; Act no. 36, 1998*, **Government Gazette**, vol. 398, No. 19182, Cape Town, Republic of South Africa, August 26th, 1998
- [12] M. Bourblanc, *State transformation and policy networks: the challenging implementation of new water policy paradigms in post-Apartheid South Africa*, **Water Alternatives**, **10**(2), 2017, pp. 303-321.
- [13] K. Conca, **Governing water. Contentious transnational politics and global institution building**, Cambridge, MIT Press, 2006, ISBN: 9780262532730
- [14] M. Bourblanc, *The South African 'Ecological Reserve', A Travelling Concept*. **Politikon**, **42**(2), 2015, pp. 275-292.
- [15] S.R. Perret, *Water policies and smallholding irrigation schemes in South Africa: a history and new institutional challenges*, **Water Policy**, **4**(3), 2002, pp. 283-300.

- [16] H. Léville, H. Sally, J. Cour, *Testing water demand management scenarios in a water-stressed basin in South Africa: application of the WEAP model*, **Physics and Chemistry of the Earth, Parts A/B/C**, **28**(20), 2003, pp. 779-786.
- [17] J.L. Nel, D.J. Roux, G. Maree, C.J. Kleynhans, J. Moolman, B. Reyers, M. Rouget, R.M. Cowling, *Rivers in peril inside and outside protected areas: a systematic approach to conservation assessment of river ecosystems*, **Diversity and Distributions**, **13**(3), 2007, pp. 341-352.
- [18] V.R. Reddy, *Water security and management: Lessons from South Africa*. **Economic and political weekly**, **37**(28), 2002, pp. 2878-2881.
- [19] E. Zerbo, *CO2 emissions, growth, energy consumption and foreign trade in Sub-Saharan African countries*, 2015, Hal-01110769 <https://hal.archives-ouvertes.fr/hal-01110769>
- [20] E.Z. Stachiv, R.A. Pietrowsky, *Adapting to climate change in water resources and water services*, **Institute for Water Resources, U.S. Army Corps of Engineers**, Alexandria, Virginia 22315-3868, 2009.
- [21] T. Oki, and S. Kanae, *Global hydrological cycles and world water resources*. **Science**, **313**(5790), 2006, pp. 1068-1072.
- [22] C.J. Vörösmarty, P. Green, J. Salisbury, R.B. Lammers, *Global water resources: vulnerability from climate change and population growth*. **Science**, **289**(5477), 2000, pp. 284-288.
- [23] L.F. Konikow, E. Kendy, *Groundwater depletion: a global problem*. **Hydrogeology Journal**, **13**(1), 2005, pp. 317-320.
- [24] K. Frederick, D.C. Major, *Climate change and water resources*. **Climate change**, **37**(1), 1997, pp. 7-23
- [25] C.A. Sullivan, C. Huntingford, *Water resources, climate change and human vulnerability, Proceedings of Interfacing Modelling and Simulation with Mathematical and Computational Sciences: 18th IMACS World Congress, MODSIM09 18th World IMACS/MODSIM Congress*, Cairns, Australia, 13-17 July 2009, Modelling and simulation Society of Australia and New Zealand, Christchurch, NZ, editors: R. S. Anderssen, R. D. Braddock and L. T. H. Newham, 2009, pp. 2377-2383
- [26] A. Westaway, *Rural Poverty In The Eastern Cape Province: Legacy of Apartheid or Consequence of Contemporary Segregationism?*, **Development Southern Africa**, **29**(1), 2012, pp. 115-125, doi.org/10.1080/0376835X.2012.645646
- [27] H. Forgey, J. Anthea, E. Sidiropoulos, C. Smith, T. Corrigan, T. Mophuthing, A. Helman, J. Redpath, T. Dimant, **South Africa Survey 1999/2000 - Millennium Edition**, South African Institute of Race Relations, Johannesburg, South Africa, 1999, ISSN 1027-1724, ISBN 0-86982-464-3
- [28] *** **The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socioeconomic Development**, UN Water/Africa, Economic Commission for Africa, African Union, African Development Bank, 2003 <https://www.sahistory.org.za/sites/default/files/SAIRR%20Survey%201999-2000.pdf>
- [29] *** **Water Resources Allocation: Sharing Risks and Opportunities**, OECD Studies on Water, OECD Publishing, Paris, 2015, <https://doi.org/10.1787/9789264229631-en>
- [30] *** *Chief Directorate: Water Use. Water Allocation Reform Strategy*, **Water & Forestry**, Water Affairs & Forestry Department, Republic of South Africa, <http://www.dwa.gov.za/WAR/documents/WARStrategySep08.pdf>
- [31] *** **Report of the Commission of Enquiry into water matters**, Department of Water Affairs (DWA), R.P. 34/1970, Pretoria, Republic of South Africa, 1970

- [32] M.S. Basson, *Water development in South Africa*, UN-Water International Conference, Water in the Green Economy in Practice towards Rio+2020, 2011, pp 1-12 www.un.org/waterforlifedecade/green_economy_2011/pdf/session_1_economic_instruments_south_africa.pdf
- [33] M. Maarleveld, C. Dabgbégnon, *Managing natural resources: a social learning perspective*, **Agriculture and human values**, **16**(3), 1999, pp. 267-280.
- [34] T.S. Veeman, J. Politylo, *The role of institutions and policy in enhancing sustainable development and conserving natural capital*, **Environment, Development and Sustainability**, **5**, 2003, pp. 317-332.
- [35] R.M. Saleth, A. Dinar, *Institutional changes in global water sector: trends, patterns, and implications*, **Water Policy**, **2**, 2000, pp. 175-199.
- [36] C. Pahl-Wostl, M. Craps, A. Dewulf, E. Mostert, D. Tabara, T. Taillieu, *Social Learning and Water Resources Management*, **Ecology and society**, **12**(2), 2007, article no. 5
- [37] B.J. Wohlwend, *Legal and institutional means to implement integrated water resources management*, 2007, www.bjwconsult.com
- [38] *** *Masibambane III Official Launch*, Department of Water Affairs and Forestry, Pretoria, Republic of South Africa, 2008, <http://www.dwaf.gov.za/Masibambane/documents/MasibambaneLaunch17Mar08.pdf>
- [39] R. Francis, *Water justice in South Africa: natural resources policy at the intersection of human rights, economics, and political power*, **Georgetown International Environmental Law Review**, **18**(1), 2005, p. 149-196.
- [40] D.D. Tewari, *A brief historical analysis of water rights in South Africa*. **Water International**, **30**(4), 2005, pp.438-445.
- [41] G. L. Moigne, A. Dinar, S. Giltner, *Principles and examples for the allocation of scarce water resources among economic sector*, **Options Méditerranéennes. Serie A: Séminaires Méditerranéens (CIHEAM)**, ISSN : 1016-121X, Agriculture and Natural Resources Department of World Bank, 1997, <http://agris.fao.org/agris-search/search.do?recordID=QC1997001460>
- [42] Department of Water Affairs and Forestry, South Africa, *White Paper on a National Water Policy for South Africa*, 1997, (accessed 1 June 2018); www.dwaf.gov.za/documents/policies/nwpwp.pdf
- [43] B. Schreiner, *Viewpoint - Why has the South African national water act been so difficult to implement?*, **Water Alternatives**, **6**(2), 2013, pp. 239-245.
- [44] G. Boccaletti, M. Stuchtey, M. Van Olst, *Confronting South Africa's water challenge*, <https://www.mckinsey.com/business-functions/sustainability/our-insights/confronting-south-africas-water-challenge#>
- [45] *** Department of Water Affairs and Forestry (1990-2010), *National Water Resource Strategy*, 2004, (accessed 1 June 2018); www.dwaf.gov.za/documents/policies/NWRS/default.htm
- [46] L. Mehta, *Water for the twenty-first century: Challenges and Misconceptions*, Brighton, UK, Institute of Development Studies, 2000 ISBN 1-85864-302-3, https://entwicklungspolitik.uni-hohenheim.de/uploads/media/Water_for_the_Twenty-First_Century-ids-workingpaper_111_04.pdf
- [47] M. Falkenmark, J. Lundqvist, *Towards water security: political determination and human adaptation crucial*. **National Resource Forum**, **22**(1), 1998, pp. 37-51 doi.org/10.1111/j.1477-8947.1998.tb00708.x

- [48] P. Wester, D.J. Merrey, M. de Lange, *Boundaries of Consent: Stakeholder Representation in River Basin Management in Mexico and South Africa*. **World Development**. **31**(5), 2003, pp. 797-812.
- [49] ***, **A Guide to World Resources 2000-2001. People and Ecosystems**, United Nations Development Programme, United Nations Environment Programme, World Bank - World Resources Institute, Washington DC, USA, <http://documents.worldbank.org/curated/en/194461468779097505/pdf/multi-page.pdf>
- [50] R.W. Adler, *The law at the water's edge: Limits to "ownership" of aquatic ecosystems, Wet Growth: Should Water Law Control Land Use?*, editor Arnold, C.A., Environmental Law Institute, Washington, D.C., USA, 2005, pp. 201-269
- [51] A.T. Wolf, *Water and human security*, Department of Geosciences, Oregon State University, 1999, <http://cip.management.dal.ca/publications/Water%20and%20Human%20Security.pdf>
- [52] A. Allan, A. Rieu-Clarke, *Good governance and IWRM - a legal perspective*, **Irrigation and Drainage Systems**, **24**(3-4), 2010, pp. 239-248, DOI: 10.1007/s10795-010-9096-4
- [53] J. Lautze, S. De Silva, M. Giordano, L. Sanford, *Putting the cart before the horse: Water governance and IWRM*, **Natural Resources Forum**, **35**(1), 2011, pp. 1-8, doi.org/10.1111/j.1477-8947.2010.01339.x
- [54] * * *, **Institutional Options for Improving Water Management in India: The Potential Role of River Basin Organization. A report on institutional options for improving water management in India**, Editor Asian Development Bank, New Delhi, India, 2007
- [55] T. Watt, *Franco-Irish privateers and the threat to order in Ireland, 1692-1716*. **IHSA Annual Conference at UCC**, University College Cork, 2011.
- [56] J. Allouche, *The birth and spread of IWRM-A case study of global policy diffusion and translation*. **Water Alternatives**, **9**(3), 2016, pp. 412-433.
- [57] J. Gallego-Ayala, *Trends in integrated water resources management research: a literature review*, **Water Policy** **15**(4), 2013, pp. 628-647, <https://doi.org/10.2166/wp.2013.149>
- [58] * * *, **Integrated Water Resource Management**, TAC Background Paper No. 4, Global Water Partnership/Technical Advisory Committee, 2000, ISSN: 1403-5324 ISBN: 91-630-9229-8
- [59] W. Medema, P. Jeffrey, *IWRM and adaptive management: synergy or conflict*. NeWater Report Series No. 7, 2005, DOI: 10.13140/RG.2.1.2838.8323
- [60] M. Xie, *Integrated water resources management (IWRM). Introduction to principles and practices*, **Africa Regional Workshop on IWRM**, Nairobi, Oct. 29 – Nov. 2006, under GEF's International Waters Learn Program, <http://pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwr/IWRM%20Introduction.pdf>
- [61] * * *, **A Handbook for Integrated Water Resources Management in basins. Global Water Partnership**, Global Water Partnership & International Network of Basin Organizations, Stockholm, Sweden, 2009, ISBN: 978-91-85321-72-8 <https://www.inbo-news.org/IMG/pdf/GWP-INBOHandbookForIWRMinBasins.pdf>
- [62] * * *, **IWRM Guidelines at River Basin Level. Part 1: Principles**, editors: United Nations Educational, Scientific and Cultural Organization & International Hydrological Programme of UNESCO - https://www.hydrology.nl/images/docs/ihp/IWRM_Guidelines/IWRM_Part_1_Principles.pdf

- [63] A.K. Biswas, *Integrated water resources management: is it working?*, **International Journal of Water Resources Development**, **24**(1), 2008, pp. 5-22, <https://doi.org/10.1080/07900620701871718>
- [64] V.S. Saravanan, G.T. McDonald, P.P. Mollinga, *Critical review of integrated water resources management: moving beyond polarised discourse*, **Natural Resources Forum**, **33**(1), 2009, pp.76-86, DOI:10.1111/j.1477-8947.2009.01210.x
- [65] * * *, **National Water Resource Strategy. Water for an Equitable and Sustainable Future**, Department of Water Affairs (DWA), Republic of South Africa, 2013, www.dwa.gov.za/documents/Other/Strategic%20Plan/NWRS2-Final-email-version.pdf
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