

A critical review of the concept of equity to support water allocation at various scales in the Amu Darya basin

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Abstract Even though ‘equity’ appears to be the major objective on all water management levels, the concept as such and its implication for water management are hardly explored within the professional water debate. Utilizing different arguments from the public sector, management and psychology debates, it is argued that the concept of equity is often undefined and usually ambiguous. The paper goes on to explore aspects of ‘equity’ of water allocation between the different riparian states in the Amu Darya basin and between the different upstream and downstream provinces in Uzbekistan and districts within the Khorezm Province of Uzbekistan.

Keywords Equity · Public sector · Resource management · Amu Darya · Uzbekistan

Introduction

The incorporation of sustainability and equity in water planning and policy goals has become a major policy priority (Gleick 1998). Indeed in the paradigm of Integrated Water Resource Management (IWRM) the concepts of sustainability and equity are incorporated. The Global Water Partnership defined Integrated Water Resource Management as a “process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (Global Water Partnership 2000). Without doubt, these sound like positive goals and it is easy to subscribe to these goals. However, what remains questionable is, what exactly is equity as regards water management and who defines this and how is it implemented in practice.

For the basin level, Wolf (1999) argues that equity is “a vague and relative term in any event. Criteria for equity are particularly difficult to determine in water conflicts, where the

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international water law is ambiguous and often contradictory”. Hence instead of defining equity, Wolf shows different approaches currently utilized on the international level, but it is debatable whether these approaches are in fact ‘equitable’ or just convenient for two or more parties sharing the basin. On the state level the concept of equity is often challenged. Using the example of indigenous communities in Latin America, Boelens (1998) and Oliverio (1998) contest the concept of equity within the state and argue against the state’s hegemonic influence. Oliverio (1998) reasons that “inherent political structure lends itself to processes of standardization but not necessarily equality, uniformity but not necessarily diversity; and institutionalization but not necessarily equity”. Boelens (1998) explains that “each culture, subculture, region, peasant community or water user association has constructed and still is constructing its local, heterogeneous conceptions of equity”. However, while they question the concept of equity within the state, because of the hegemonic influence of dominant groups, it appears that they do not question the concept of equity within the local community and the hegemonic influence of local dominant groups.

Even though, the concept of ‘equity’ is promoted and contested at the same time, it is not very evident what is actually being promoted or contested. Hence the issue of what it is, that makes the concept of equity so controversial? The next section critically examines the concept of equity. This is followed by two sections looking first at equity issues regarding transboundary water allocation and distribution within the Amu Darya basin and second within different upstream and downstream provinces and districts within Uzbekistan. The last section offers some broader conclusions.

Opening the “black box” on the concept of equity

In the context of social welfare policy equity has two components, ‘proportionality’ and ‘egalitarianism’. Proportionality implies that resources should be distributed according to people’s effort or ‘deservedness’. Egalitarianism suggests that everyone should be treated equally (Syme et al. 1999). On a similar line, Waters (2000) distinguishes between vertical and horizontal equity in the welfare system. While vertical equity measures the extent to which individuals with unequal needs receive appropriately different levels of care, horizontal equity is a measure of equal treatment for those with equal need. However, vertical or proportionally could imply, that larger shares receive larger inputs or returns. Hence, proportionality could either imply redistribution or confirmation of the existing allocations. In terms of horizontal equity, an egalitarian service provision does not give any indication about the level of service provided and whether the provided service meets the needs of the community or individuals within.

According to Gleick (1998) equity is a measure of the fairness of the distribution and the process used to arrive at particular social decisions. Hence, he distinguishes between two levels of equity. Cremers et al. (2005) distinguish between five levels of equity in irrigation and water management at the local level: equitable water distribution and allocation among different water users and uses; equitable distribution of the services involved in irrigation development; equitable distribution of the added agricultural production and other benefits under irrigation; equitable distribution of the burdens and obligations related to functions and positions; and equitable distribution of the rights to participate in the decision-making process”. It is not evident whether Gleick (1998) or Cremers et al. (2005) use for their distinction of equity a proportional or egalitarian approach or a mix of those two approaches. Therefore, it is not evident what the starting point is and what the outcome would be. For example, would it imply for the local level, that water users who have more

land have a higher proportional right to water as an input and more voting power in decision making? The same logic could be applied for equitable distribution of benefits, again it would be questionable whether this implies proportionality or egalitarianism. Meaning, if proportionality applies, the have-nots stay in their position, of not having anything, and would not gain anything either. Furthermore, their different levels suggest, that the five identified levels of equity are compatible with each other. However, this is not implicit. Savas (1978) showed the problem of equity of public service provision in general. He takes an approach which focuses on egalitarianism. He argues that there could be four different principles of equity: equal payments, equal outputs, equal inputs, and equal satisfaction of demand. However, equal payments might neither lead to equal inputs or outputs; to achieve equal outputs it might be that very unequal inputs have to be applied; and equal inputs might not lead to equal outputs. Finally, he argues that equal satisfaction of demand has three different dimensions: equal inputs per unit of demand, equal inputs per complaint, or equal inputs per politically weighted complaint. Again equal inputs might not lead to equal outputs. Conclusively, Savas (1978) argues, “each formula is manifested equitable in certain important respects. Yet, each is clearly inequitable in terms of the other, competing principles. It comes as no surprise that equity is a matter of values.” In the end of the day, decisions on equity are political decisions.

Going back to the statement by Gleick (1998) of equity being a measure of fairness of the process used to arrive at particular social decisions. Similar to the statement of Cremers et al. (2005) on “equitable distribution of the rights to participate in the decision-making process”. Again, when it comes down to the different aspects of equity there seems to be a very different perspective on procedural justice. Using Rasinski (1987) Syme et al. (1999) argue that “people subscribing to the proportionality view of equity would tend to be more concerned with procedural justice issues when judging the fairness of government allocations than would those with an egalitarian viewpoint”. They conclude, that “procedural justice alone might not be a sufficient criterion for perceptions of just decision-making”. This can be very nicely illustrated when combining equity and sustainability. Levite and Sally (2002) argue that sustainability and equity are in opposition to each other. The “three principles are underscored: equity, sustainability and efficient and beneficial use for the society, forming a kind of triangle of constraints for decision-making”. If sustainability is to be defined narrowly, the questions of equity could be excluded and sustainability could be achieved under morally reprehensible conditions. Therefore, Gleick (1998) argues that “questions of equity overlap with sustainability when trying to determine what is to be sustained, for whom it is to be sustained and who decides”. In this case, it might not even really matter whether one has an egalitarian or proportional approach. In the case of it being proportional then the largest shareholder (of a defined good) would have the most voting power. Hence, in this case the defined good could be water and the utilization of water resources. It could even imply that the largest user (agriculture) could determine the agenda. On the other hand, the defined good could be the environment. Hence, the proportionality could imply that the people who suffer most from the environmental degradation should have the highest voting power. Hence, the question in this case would be the proportionality of what good. In the case of egalitarianism then the majority would decide, the majority might not, or only marginally, or only in the long term, be affected by the unsustainable situation. Hence, in certain cases the issue of sustainability might not even be on the agenda.

To make the whole debate even more complicated, Syme et al. (1999) argue that fairness principles are applied differently at the universal (agreement with prior rights in general) and situational (priorities for existing local irrigators) levels. Based on different case

studies, they deter that “when personal income and livelihood are affected, issues such as the public good, procedural justice and environmental rights tend to take the ‘back seat’”. Hence, using the concept of equity, allows having different interpretations depending on the situation and the level it is addressed.

Looking at relationships, Davidson (1984) argues that individuals who are involved in inequitable relationships manifest distress. According to him, this applies to both the under-benefiting and over-benefiting of individuals. For him, “the distress engendered by being over-benefited may take the form of guilt or shame” and therefore lead to compensation mechanisms. However, this would imply that there is only a comparison between the two individuals within the relationship. Carrell and Dittrich (1978) argue in the case of equity between employees, “While compensation and effort are significant outcomes and inputs, dimensions of perceived equity or fairness extend far beyond simple effort/pay relationships and comparisons with a single nearby referent person”. Hence, the measure of equity is not necessarily connected to the direct context but to the wider environment. Hence, the concluding remark of Davidson (1984) has even a wider dimension, “equity is considered to lie in ‘the eye of the beholder’”.

The debate shows that the concept of equity is quite undefined. Young (1994) even argues:

The arguments against existence (of equity) take three different forms. The first is that equity is merely a word that hypocritical people use to cloak self-interest – it has *no intrinsic meaning* so therefore fails to exist. The second – is that even if equity does exist in some notional sense, it is so hopelessly subjective that it cannot be analyzed scientifically – it fails to exist in an *objective* sense. The third argument that there is no sensible theory about it – thus it fails to exist in an *academic* sense. (in Syme et al. 1999).

The next section explores the different aspects of equity within the Amu Darya basin.

Issues of ‘equity’ in the Amu Darya basin

The Amu Darya is the largest river in Central Asia. It is formed by the confluence of its main headwater tributaries, the Vakhsh and Pyanj rivers. The total length of the Amu Darya from the head of the Pyanj river to the Aral Sea is about 2,540 km. The catchment area (Fig. 1) of the basin comprises 309,000 km² and is shared by Afghanistan and four Central Asia Republics: Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The Amu Darya basin can be described as a large drainage system which terminates in the Aral Sea. The tributary Vakhsh originates in the alpine regions of the Pamir Alai in the south-east territory of Kyrgyzstan, where parts of the Abramov glacier and the Fedchenko glacier contribute to the run-off generation. The tributary Pyanj originates at the glacier in the Vakjdjir Pass, and forms the border between Afghanistan and Tajikistan.

In 1977 Afghanistan sent a delegation to Tashkent (capital of Uzbekistan) to prepare a water sharing agreement between the Soviet Union and Afghanistan. The delegation wanted to claim an equal share of the river flow, but no agreement on water allocation was reached (Qaseem Naimi 2005). Only on March 12, 1987, were the allocation limits set for the Amu Darya and the “four Aral Sea Basin States formally endorsed these limits in Moscow on September 10, 1987, as Protocol 566.” (PA Consortium Group and PA Consulting 2002) However, these states were Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Representatives of Afghanistan did not participate in the meeting. The same report states, “it appears that the available annual flow of 61.5 km³ assumed diversion by Afghanistan at that time of 2.1 km³.” (PA Consortium Group and PA Consulting 2002)

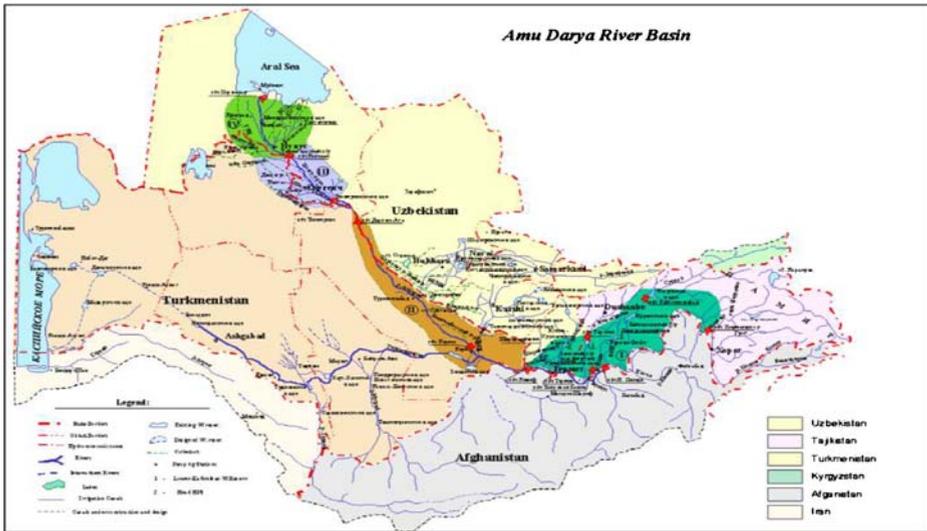


Fig. 1 The Amu Darya (PA Consortium Group and PA Consulting 2002)

Hence, the limits set in 1987 ignored the claims by Afghanistan, and the assumed water utilization of Afghanistan was even lower than what was already used in 1965, namely 3.85 km^3 (Qaseem Naimi 2005). The set limits did neither reflect “equitable” distribution among the Soviet republics nor between all the basin states, but fitted the Soviet interest to produce cotton and rice in downstream Turkmenistan and Uzbekistan (Table 1). Besides being inequitable between riparian states, it was also inequitable between the sectors within the Amu Darya basin. Zonn (1999) argues, that government authorities believed that the increment in the output of agriculture and animal husbandry in the Aral Sea basin as a whole would be much higher, than the total direct damages caused by the desiccation of the Aral Sea (fisheries and fur trade).

Since the end of the hegemonic power of the Soviet Union, but particularly since the end of the civil war in Tajikistan and the fall of the Taliban regime in Afghanistan, the upstream countries are interested to claim a more equitable share of the water, which is generated on their territory. During the Soviet Union, Tajikistan benefited by being integrated into the larger economy, and was therefore somehow compensated for not utilising its water potential, with the disintegration of the Soviet Union the compensation mechanisms ceased to exist. Being independent, Tajikistan has to make the most of its water potential.

Table 1 Water distribution limits in the Amu Darya basin following Protocol 566 of March 12, 1987

	Limit (km^3/year)	Share (%)
Uzbekistan	29.6	48.2
Tajikistan	9.5	15.4
Kyrgyz Republic	0.4	0.6
Turkmenistan	22.0	35.8
Total for Basin	61.5	100
Allocations downstream of the Kerki gauging site		
Uzbekistan	22.0	50
Turkmenistan	22.0	50

(PA Consortium Group and PA Consulting 2002)

Afghanistan on the other hand, was during the period of the Soviet Union not in a power position to claim its equitable share. With the fall of the Taliban and the rise of international attention and aid, Afghanistan's power position changed and therefore she could claim a more equitable share (Wegerich 2007b). This discussion suggests three aspects of equity. First, for Tajikistan, it appears that equity cannot be reduced to one resource alone but has to be understood within a larger framework. To consider it a simple matter of compensation would be too narrow a definition. Secondly, for Afghanistan it could indicate, although there is no real evidence to support this claim, that inequity is relative, and that maybe one does not only compare to others who are better off, but also to others who are similar or worse off. Hence inequity might be perceived differently according to varying bargaining positions. Thirdly, it shows that the perception of equity is inextricably linked to time and the larger environment, hence the perception of equity and inequity are dynamic.

Currently, according to an International Crisis Group (2002) report Uzbekistan perceives its allocated water share, compared to Turkmenistan, as *unfair*, "since fourteen million inhabitants depend on it in their country compared to four million in Turkmenistan. Besides that Uzbekistan has more land, and water has to be transported over longer distances". Here, the argument seems to be based on "equitable" in terms of demand and in terms of efficiency of distribution. On the one hand it is questionable whether the question of demand is justified in general, given the high allocation to Uzbekistan and the low allocation to Afghanistan with a total population of 22.9 million in 2002. Considering the length of the Kara-Kum canal (length: 1,400 km, intake: 10–12 km³/year) the argument made by Uzbekistan seems to be valid in terms of water efficiency (Orlovsky and Orlovsky 2002; O'Hara 1997). However, one could also compare this with the operating costs (only considering energy) of the large pump stations located in Turkmenistan bringing water to provinces in Uzbekistan: Kashkardarya (discharge: 350 m³/s, lift: 170 m) and Bukhara (discharge: 270 m³/s, lift: 57 m). Bucknall et. al (2001) have calculated the viability of agriculture in these two provinces. If farmers are charged only the energy costs of the pump irrigation system, 64% of the irrigated agriculture in Kashkardarya province would have negative gross margins, and would be unprofitable. It therefore appears that on closer consideration of the different aspects of equity that the debate about equitable water use in the basin could go in many directions. In addition, there seems to be a seasonality problem attached to the allocation limits of the different basin states.

According to un-official data of the Amu Darya basin organization (BVO), Tajikistan utilised a constant amount of water, during the period 1991–2001, with the exception during the time of the civil war in Tajikistan. However, during the drought years of 2000 and 2001, Tajikistan utilised 7.6 and 7.3 km³, respectively. The water amount utilised in the drought year of 2000 is even higher than used in 1991 (7.3 km³). In addition, Fig. 2 shows that there is a higher level of variation in Uzbekistan's water utilization compared to Turkmenistan, any variation of the annual river flow affects Uzbekistan stronger than any upstream state.

Issues of 'equity' within Uzbekistan

In Uzbekistan, equitable water distribution between the different provinces is anticipated. The official water demand is calculated based on the following indicators:

- Structure and area of cropped land;
- Irrigation regime (method, norm and period); and
- Efficiency of irrigation network and irrigation technique (TACIS 1997).

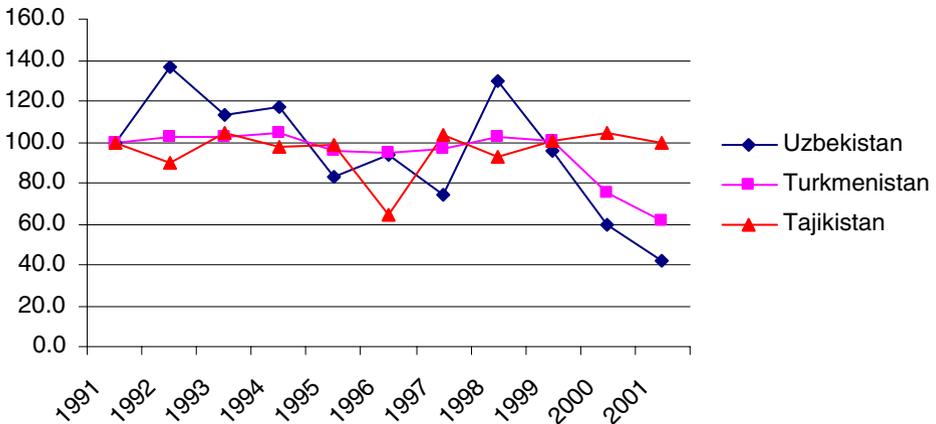


Fig. 2 Seasonality of inequalities in the Amu Darya basin (reference point 1991) (BVO Amu Darya, not published)

As argued above, this can be considered equitable as based on “equal [water] inputs per unit of demand”. However, this is an egalitarian approach with three vertical implications. Firstly, the largest land holder has the right to the largest share of the [input] water. Secondly, the most inefficient delivery system and irrigation method has the right to the highest amount of water. Thirdly, the crop which needs the most water will receive most water. Hence, one can deduce that the largest land holder with the most inefficient water delivery system, the worst irrigation method and the most profitable crop (very often this is rice or cotton) has the right to the largest amount of water. Under this consideration, practiced ‘equity’ in Uzbekistan appears to be in direct contradiction with environmental sustainability despite the fact it appears to be supporting social sustainability (if one interprets sustainability as manifesting the status quo, in this case social inequality) (Wegerich 2007a). On the other hand, this approach is equitable in the sense of ‘egalitarianism’, because it excludes the other input costs (such as energy). Hence, if the largest land holder, with the most inefficient water delivery system, the most inefficient irrigation method and the most water demanding crop is located in Kashkardarya, and water has to be pumped up 130 meters and therefore would have the highest negative profits margins, he/she would still receive the largest amount of water.

Officially, in situations with water shortages, the allocations for each province are adjusted, so that equitable distribution according to the above indicators among the provinces prevails. Even though a reasonable forecast is vital to agricultural planning, an ICWC bulletin (1997) states that the error of forecasting in spring is between 30 and 50% and that the error can only be corrected in July. However, by this time farmers have already started to grow their crops. To readjust at that time to the lower water availability would imply that inputs have been wasted. Hence, any readjustment to lower water availability would imply a loss of investment. As a result of the prevailing state order system for agricultural crops in Uzbekistan, the loss hits not only the farmer, but also each administrative unit (province and district). Therefore, even though equitable distribution is anticipated, it appears that during water shortages there are problems of implementing the policy. Dukhovny (2002) reports “while Uzbekistan and Turkmenistan as a whole received their shares (75% of the previous limit) upstream regions in both countries received 85–100% of the limit but downstream areas (Karakalpakistan in Uzbekistan and Dashauz in Turkmenistan) had less than 50%” (Table 2).

Table 2 Diverted annual flow of upstream provinces in Uzbekistan (BVO Amu Darya, not published)

Diverted annual flow (km ³ /year)											
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Amu-Bukhara	4.7	3.9	3.4	4.2	4.6	4.9	4.8	4.4	5.0	4.3	4.0
Amuzang	1.2	0.7	0.8	0.8	1.0	1.1	1.3	0.8	1.2	1.5	1.6
Kashkardarya	4.8	4.2	4.1	4.4	4.3	4.8	4.9	4.5	4.3	4.1	4.1
Amu-Bukhara	100.0	82.6	72.8	89.9	98.1	104.5	102.1	94.3	107.8	92.5	86.0
Amuzang	100.0	60.5	70.2	68.5	82.4	96.0	104.6	67.3	99.3	126.7	135.3
Kashkardarya	100.0	87.0	85.6	91.1	88.8	99.1	101.7	92.9	89.1	83.7	85.0

Dukhovny (2002) explains that “these regions are certainly not ‘enemies’ to each other, but they are driven by their own individual interests, and cannot leave water unexploited for ‘unknown’ others”. The explanation confirms the argument above on the seasonality of equity. Hence, it appears that there is a change in the concept of equity between the different provinces in case of water scarcity. The seasonality of equity combined with the exclusion of energy costs has resulted in the most costly irrigated agriculture receiving, proportionally, the largest amount of water during the period of drought in 2000–2001. Given the fact, that even though all of these provinces are ruled under the same national leadership, and should have ‘equal’ rights but also responsibilities towards the whole, it appears that seasonality shifted the normal ‘equitable’ approach to the ‘first-come–first-take’ approach. On the other hand, one could also argue, that during water scarcity a different approach is taken: ‘equal [water] inputs per politically weighted demand’. But this claim cannot be substantiated. In any of these two cases, it is unclear what prevented these upstream provinces from taking their full share and whether it was guilt or the lack of power to do so. However, according to a key employee of the Basin Water Organization (BVO) of the Amu Darya, the BVO is only responsible to allocate the different international agreed shares to the individual countries. Hence, what happens within the country is up to the individual basin states. (informal interview, Urgench 2003).

The seasonality of equity or ‘equal [water] inputs per politically weighted demand’ is not only common amongst provinces but also between districts within one province. The inequitable distribution does not only get furthered by the inability of the province and district water management organisations to control exploitation (Wegerich 2004a), but also through the power and influence of individual power players, hakims (governors) and shirkat (formerly state and collective farms) managers. These power players utilise their networks to increase their individual share and to further the interest of their administrative unit (Wegerich 2004b).

What has been excluded from the debate of equity so far, but which is very important in terms of equitable distribution of water for irrigation, is the timing of water delivery. The timing of course is important not only on the basin scale but also at the lower administrative levels. Ruecker and Conrad (2003) show by utilizing time-series of the vegetation parameter ‘leaf area index’ (LAI) and land use data from satellite sensors that LAI as an indicator for vegetation growth was not equally distributed within the system. However, distinct spatial and temporally changing LAI patterns depending on relative upstream and downstream positions within the irrigation system and their distance from the main irrigation channels were found. Spatially and temporally heterogeneous water distribution was assumed to be one of the major causes for these heterogeneous vegetation growth patterns. Thus farmers who have fields adjacent to the river or to larger (district or inter-district) irrigation canals have the comparative advantage of getting more and earlier water

than farmers downstream or at the tail end of smaller irrigation canals. Hence, this shows that not the 'equal [water] inputs per unit of demand', but also the response time to the demanded input has to be taken into consideration. Given the large scale irrigation infrastructure, it appears that equity between head- and tail-enders in terms of inputs of demanded water is uncertain, given the aspect of seasonality (here water scarcity). In addition it appears that downstream farmers and tail-enders are in a disadvantaged position given the aspect of timing. Of course, the location within the irrigation system might already give an indication about the political influence (Bucknall et al. 2001; Wegerich 2007a).

Conclusion

Even though a quest for equity is popular at the current time in the water policy debate, the discussion on equity has shown that equity is an ambiguous concept. For example, a policy intention to establish equity on one matter might imply inequity on a different matter (equity of inputs could lead to inequity of outputs). In addition, if the perceptions on equity are bound to time (seasonality) but also to the larger environment, then equity perceptions are dynamic and equity among stakeholders has to be renegotiated constantly. Furthermore, if equity has two components proportionality and egalitarianism, it appears to be a political decision from the outset choosing which component should be followed. Where decision making is concerned, the choice is whether the participants of the decision making process have an equal vote or a weighted vote (such as based on land holding, contribution, need, efficiency or productivity, but maybe even degree of 'belongingness' to the group, culture, gender, ethnicity or political influence). In either case the outcome of the decision making process might not be perceived as equitable by all members of the group.

The debate on water distribution within Uzbekistan indicates that the general problem with equity in terms of the three egalitarian principles has negative effects and proportional consequences. The policy could lead to a manifestation of social inequalities as well as economic and environmental unsustainability. Instead of using an egalitarian principal, a proportional principle has to be found, which protects marginal groups, tail-enders as well as leading to environmentally sound, economical and rational use of water. Furthermore, if the state organizations themselves are responsible for inequitable distribution among the different administrative units, this highlights the need for either independent water management organizations, or the need to make the administrative units responsible for the occurred losses of further downstream administrative units by paying compensation. However, as the debate on equity has shown, equity and therefore also compensation for inequity, is an individual interpretation, therefore the group who suffered should determine the level of compensation. Of course this would assume that the group perception is unique, which it is not.

Although equity is an ambiguous concept, and in all probability every situation which is called equitable by some can be perceived as inherently inequitable by others, the concept as such does have a positive connotation. What is questionable however, is whether it is appropriate for outsiders, such as the Global Water Partnership, to demand equity, if it is only the insider's perception that can determine whether a situation is equitable or not. In addition, how realistic is it, to demand equity for one resource, if the wider context in which it is delivered is inequitable.

For the researcher, the outsider, it appears not be interesting whether a situation is equitable as such, something he/she might have a different perception of anyway, but more, what are the discursive struggles on equity and who argues and why does he/she/the group argue that a certain situation is equitable.

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References

- Boelens R (1998) Equity and rule-making. In: Boelens R, Davila G (eds) Searching for equity: conceptions of justice and equity in peasant irrigation. Van Gorcum, Assen
- Bucknall J, Klytchnikova I, Lampietti J, Lundell M, Scatista M, Thurman M (2001) Irrigation in Central Asia: where to rehabilitate and why, report. World Bank Group, Washington, DC
- Carrell MR, Dittrich JE (1978) Equity theory: the recent literature, methodological considerations, and new directions. *Acad Manage Rev* 3(2):202–210
- Cremers L, Ooijselaar M, Boelens R (2005) Institutional reform in the Andean irrigation sector: enabling policies for strengthening local rights and water management. *Nat Resour Forum* 29:37–50
- Davidson B (1984) A test of equity theory for marital adjustment. *Soc Psychol Q* 47(1):36–42
- Dukhovny V (2002) Big challenges and limited opportunities: what are the constraints on cooperation. In: Bogardi J, Castelein S (2002) From conflict to co-operation in international water resources management: challenges and opportunities, UNESCO-IHE Delft, The Netherlands, 20–22 November 2002, pp 119–124
- Gleick PH (1998) Water in crisis: paths to sustainable water use. *Ecol Appl* 8(3):571–579
- Global Water Partnership (2000) Integrated water resource management, TAC background papers No. 4, <http://www.gwpforum.org/gwp/library/TACNO4.PDF>
- ICWC, Bulletin No 14, 1997, <http://www.cawater-info.net/library/eng/icwc/>
- International Crisis Group (2002) Central Asia: water and conflict, Asia report no. 34, Osh/Brussels
- Levite H, Sally H (2002) Linkages between productivity and equitable allocation of water. *Phys Chem Earth* 27:825–830
- O'Hara S (1997) Irrigation and land degradation: implications for agriculture in Turkmenistan, Central Asia.. *J Arid Environ* 37(1):165–179 (Sept.)
- Oliverio A (1998) Reclaiming equality, equity and diversity. In: Boelens R, Davila G (eds) Searching for equity: conceptions of justice and equity in peasant irrigation. Van Gorcum, Assen
- Orlovsky N, Orlovsky L (2002) Water resources of Turkmenistan: use and conservation. Paper presented at workshop on water, climate, and development issues in the Amu Darya basin, Philadelphia, PA
- PA Consortium Group and PA Consulting (2002) Transboundary water and related energy cooperation for the Aral Sea Basin Region of Central Asia, (Funded by: U.S. Agency for International Development Regional Mission for Central Asia Office of Energy and Water)
- Qaseem Naimi M (2005) Conflict prevention and the politics of Central Asia water cooperation from the point of view of Afghanistan. Paper presentation at Workshop: University of Peace, Central Asia Program, Regional water resources and peace building, Almaty, 23–27/04/2005
- Rasinski KA (1987) What's fair or is it? Values differences underlying public views about social justice. *J Pers Soc Psychol* 53:201–211
- Ruecker GR, Conrad C (2003) Exploring leaf area index development and land cover classification in the Lower Amu-Darya Basin in Uzbekistan based on multi-temporal and multi-spatial remote sensing data. ZEF Work Papers for Sustainable Development in Central Asia 5, 25 pp
- Savas ES (1978) On equity in providing public services. *Manage Sci* 24(8):800–808
- Syme GJ, Nancarrow BE, McCreddin JA (1999) Defining the components of fairness in the allocation of water to environmental and human uses. *J Environ Manag* 57:51–70
- TACIS (1997) Water resources management and agricultural production in the Central Asian Republics, formulation and analysis of regional strategies on land & water resources. WARMAP Project
- Waters HR (2000) Measuring equity in access to health care. *Soc Sci Med* 51:599–612
- Wegerich K (2004a) Organizational problems of water distribution in Khorezm, Uzbekistan. *Water Int* 29 (2):130–137
- Wegerich K (2004b) Network structures and water distribution in two districts in Khorezm, Uzbekistan. *Local Environ* 9(4):337–352
- Wegerich K (2007a) Furthering inequality through land reforms in Yangibazar district, Uzbekistan. *J Cent Asian Stud* (in press)

-
- Wegerich K (2007b) Hydro-hegemony in the Amu Darya basin. *Water Policy* (under review)
- Wolf AT (1999) Criteria for equitable allocations: the heart of international water conflict. *Nat Resour Forum* 23:3–30
- Young HP (1994) *Equity: in theory and practice*. Princeton University Press, Princeton, NJ
- Zonn IS (1999) The impact of political ideology on creeping environmental changes in the Aral Sea basin. In: Glantz M (ed) *Creeping environmental problems and sustainable development in the Aral Sea Basin*. Cambridge University Press, Cambridge, pp 157–190