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To cite this article: Melinda Davies & Nathaniel Matthews (2021): Water futures along China's Belt and Road Initiative in Central Asia, International Journal of Water Resources Development, DOI: [10.1080/07900627.2020.1856049](https://doi.org/10.1080/07900627.2020.1856049)

To link to this article: <https://doi.org/10.1080/07900627.2020.1856049>

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 Published online: 25 Jan 2021.

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Water futures along China's Belt and Road Initiative in Central Asia

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ABSTRACT

China's Belt and Road Initiative (BRI) is anticipated to have wide-ranging impacts on the countries of Central Asia. This includes a significant impact to a complex and fragile water resources landscape, and the closely entwined economic, social, environmental and political context. Water resources considerations are currently not explicit in BRI policies or proposals, despite the vast variety of ways in which the initiative may interact with and influence these dynamics. This article presents an early examination of the key trade-offs and interdependencies across water management in the BRI and it includes recommendations to mitigate detrimental impact and promote sustainable delivery for the future.

ARTICLE HISTORY

Received 7 January 2020
Accepted 22 November 2020

KEYWORDS


Belt and Road Initiative (BRI); China; Central Asia; water resources management; transboundary water security; agriculture

Introduction

China's proposals for a Belt and Road Initiative (BRI) were announced by Chinese President Xi Jinping in September and October 2013 during visits to Kazakhstan and Indonesia. This paper focuses on the Belt component of the BRI, which was announced in Kazakhstan, as the land-based portion of an enormous geopolitical strategy for economic and political engagement to connect Southeast Asia to markets throughout Russia, Europe, the Middle East and beyond (Vakulchuk & Overland, 2019). Once operational, the vast economic corridor and infrastructural network delivered under the proposals could provide China with access to an estimated 60% of the world's population, one-third of global wealth (Chugh, 2017), and a greatly enhanced range of natural resources, including critical inputs to energy production, industry and agriculture (Swaine, 2015).

The implications of the BRI are anticipated to be enormous in terms of both the breadth of its scope and the ambition of its goals (Kohli et al., 2019). However, currently, despite some broad timetables, there is a lack of clearly defined targets that make it difficult to assess the BRI in terms of success or failure (Ghiasi & Zhou, 2017). As such, the BRI now covers a plethora of spatially and temporally expanding state and privately driven projects, including infrastructure projects, investments, loans and trade agreements by state, private and public-private enterprises (Bird et al., 2019; Hofman, 2016).

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 Supplemental data for this article can be accessed [here](#).

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At the historic core of the ancient Silk Road trading network, Central Asia occupies both the gateway and centrepiece of China's BRI initiative and will play a major role in its success or failure (Zhang, 2015). Encompassing the former Soviet republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, the area has a combined population of 66 million. Since the launch of the strategy, China's influence in these neighbouring states has been growing at a fast pace (Reeves, 2018), with the effects of global trade, investment and infrastructure likely to have profound and wide-ranging impacts on the region. There is potential for substantial investment to stimulate much needed growth and prosperity (Bird et al., 2019), bringing profound economic benefit to some of the world's most impoverished areas (Howard & Howard, 2016).

Influencing and interacting with these dynamics, both China and its neighbouring Central Asian countries are beset by a complex set of water issues, which have already been highlighted as one of the most serious problems along the route of the BRI (Li et al., 2017), covering concerns associated with water, food and energy security, regional resource disparity, mismanagement, pollution and environmental degradation.

The primary source of freshwater for Central Asia's rivers and aquifers lies in the mountain ranges of Pamir and Tien Shan, where mean annual precipitation ranges between 800 and 1600 mm, and snow and glacial meltwater contributes significantly to both surface water and aquifer recharge in the warmer months (Gafurov et al., 2019; Howard & Howard, 2016). The majority of both surface and groundwater resources are thought to be transboundary, with the upstream nations of Tajikistan and Kyrgyzstan possessing approximately 80% of the water resources serving the region through controlling flows from the primary Syr Darya and Amu Darya rivers (Djumaboev et al., 2020; Zhang, 2015). Downstream, Uzbekistan, Kazakhstan and Turkmenistan are highly vulnerable to water shortages, with 90% of their water resources coming from mountains located outside their borders (Critical Ecosystem Partnership Fund (CEPF), 2017). Regional groundwater resources are of high importance, providing significant storage and interacting closely with surface water systems. However, the groundwater system is still not well monitored or understood, and there is a clear need for integrated consideration across the whole water cycle to drive sustainable management (Gafurov et al., 2019).

Much of the proposed belt area in Central Asia is located in semi-arid and arid regions (Chen et al., 2016), with a fragile ecological environment and countries exhibiting water-stress levels amongst the highest in the world (Gassert et al., 2013; Zou et al., 2019). The vast majority of water resources are harnessed for agriculture; however, they are used ineffectively and there is a risk that improper development could cause environmental problems, and even stimulate an ecological crisis (Li et al., 2015). Due to human interference, land degradation, including soil pollution, soil salinization and desertification, has already become a serious issue, and intense competition for water among agricultural, industrial and domestic needs has elevated the stress on groundwater resources (Li et al., 2016).

Historically, all the countries of Central Asia were part of the Union of Soviet Socialist Republics (USSR), under which they experienced an intensive period of coordinated large-scale water engineering development, leaving a legacy of (now poorly maintained) diversionary irrigation canals (Piesse, 2017). Whilst this system produced significant agricultural and energy outputs, the trade-offs on the environment were not well managed, as embodied by the devastating degradation of the Aral Sea and its ecosystem, now comprised of disparate waterbodies surrounded by a vast saline desert (Xenarios et al., 2018; Ziganshina, 2009).

In future, current projections indicate that Central Asia will be particularly exposed to the anticipated impacts of climate change (from both an environmental and an adaptive capacity perspective) and that this will have implications on the emergence of water trade-offs and availability of management options (Djumaboev et al., 2020; World Bank, 2015; Zou et al., 2019). Numerous studies have analysed the potential impacts of climate change in the area and a significant uncertainty of impact extent exists; however, a clear historic and projected warming trend is apparent. Long-term projections generally indicate the retreat of non-renewable glaciers, reduced snow cover, altered river flow regimes, changing distribution and intensity of rainfall, and an overall likelihood of reduced water availability (Djumaboev et al., 2020; Punkari et al., 2014; World Bank, 2015). Temperature impacts are further anticipated to significantly increase irrigation demand (Punkari et al., 2014; World Bank, 2015), requiring the radical adaptation of agricultural practice (Milanova et al., 2018). Furthermore, rapid population growth is expected to increase the population of Central Asia by 35–40% by mid-century (United Nations, 2015), which is likely to substantially exacerbate current levels of water and ecosystem stress.

Development of the BRI through Central Asia is anticipated to further increase industrial and agricultural activities and population in localized areas along the route (Vakulchuk & Overland, 2019). Water issues are already recognized as possibly the most serious problem along the route, and there are concerns that the resulting increase in competition for water resources among agricultural, industrial and domestic uses may lead to a further increase in levels of regional water stress (Chen et al., 2016; Martens, 2018). Within this context, there are questions whether the development proposed through the BRI, and the rapid economic stimulation it will bring, will place too great a burden on an already disjointed and dysfunctional water management system (Howard & Howard, 2016; Reyer et al., 2017). Equally, the escalation of rising hostilities could impact adversely upon the regional integration required for connectivity of the BRI, particularly if stimulated by Chinese energy investment (Piesse, 2017).

The Chinese government is aware of the challenges of managing the trade-offs and interdependencies in water management, as clearly demonstrated by the land, water and energy use commitments within its 13th and 14th Five Year Plans (Neuweg & Stern, 2019). However, despite this awareness, integrated water management has not been prominent in Chinese activities abroad historically. This includes the development of multiple hydro-power dams in the Mekong region constructed by Chinese state-owned enterprises (SOEs) that have done little to address trade-offs and interdependencies, particularly concerning negative transboundary implications on environmental flows and fisheries (Matthews & Motta, 2015).

Transboundary water cooperation across the five Central Asian states was initiated through the establishment of the International Fund for Saving the Aral Sea (IFAS) in 1993, and several subordinated bodies including the Interstate Commission for Water Coordination (ICWC). Whilst effective transboundary cooperation on water resources faced significant challenges for the following quarter century, the dialogue between the partner states is now intensifying (Cassara et al., 2019), and the countries of Central Asia are increasingly looking towards river basin management approaches (Organisation for Economic Co-operation and Development & United Nations Economic Commission for Europe (OECD–UNECE), 2014). However, there remains a prominent need for the delivery of holistic integrated water management (IWM) approaches and harmonization of

transboundary policies across the region (Ibatullin & Ziganshina, 2020). Key regional studies further highlight need for greater equality, sustainability, transparency and participation in water resources issues from the local to the transboundary level (Dukhovny & Horst, 2008; Martens, 2018). Progress in delivering this has historically been slow, and there is a risk an ongoing lack of such shared vision will continue to increase competition and degrade natural resources, especially under the future challenges of climate change (Horsman, 2018; Soliev & Theesfeld, 2020). This paper examines the possible water futures across Central Asia paying particular attention to interdependencies, choke points and trade-offs in water management to uncover leverage points and possible solutions.

Methodology

This research sheds a further light on the possible future water management scenarios from the BRI and their trade-offs in Central Asia, employing extensive literature analysis complemented by targeted stakeholder interviews.

The literature review and critical analysis covering over 90 data sources was undertaken, including academic publications, media articles and grey literature, comprising reports published by government and non-government organizations (NGOs), research institutions and consultancies. Much of the publicly available information regarding specifics of Chinese–Central Asian cooperation is published in Russian or Chinese and, despite broadly scoped search, the limited availability of English translations is likely to have constrained the scope of this review. A detailed list and categorization of all sources examined is provided in Table A1 in the supplemental data online. This information was used to establish the available baseline information on the state of the water resources within the study area, and the proposed and projected regional agricultural cooperation, development and investment under the BRI initiative in order to draw conclusions regarding potential outcomes.

This research was complemented and further developed through targeted interviews and discussions with stakeholders and regional experts in order to gain a greater understanding of locally and internationally perceived issues and implications of development under the BRI. The concepts of integrated water management have heavily influenced this analysis, considering both direct and indirect impacts of the BRI on the whole water cycle, and considering the spectrum of subsequent implications for its multiple values and uses.

A cross-section of 12 stakeholders and regional experts with varying interests within the region were interviewed, identified through their recognized subject area expertise or position in targeted relevant organizations, and diverse perspectives. This included government agencies, consultancies, NGOs and academics. As such, ‘elite interviewing’ techniques were employed within the interview design and delivery, using open-ended questions and a semi-structured format (Hochschild, 2009). Elite interviewing refers to interviewing those who are chosen by name or position for a particular reason with a central aim to acquire information and context that only that person can provide (Hochschild, 2009). The intention of this was to consider the interviewee’s expertise in relation to Central Asia and allowing them to partially shape the direction of the interview.

All interviews were designed to last up to one hour (although timing was extended where an individual’s circumstances allowed) and a semi-structured interview script prepared with a focus on open-ended questions was intended to take into account

Table 1. Interviewee professions and references.

Category	Description	Interviewee References
Academic	University professors and researchers	A1, A2, A3
Journalist	Local and international journalists	J1, J2
Professional consultant	Consultant with local expertise, both privately and publicly affiliated.	P1, P2, P3, P4, P5
NGO activists	Employees of relevant NGOs	N1, N2

each interviewee's experience and leverage upon specific areas of knowledge or expertise. All interview data collected were maintained as anonymous, and are reported only in an anonymous format, referenced in Table 1. A sample interview script is provided in the supplemental data online.

There were limitations inherent in the methodology employed within this research. The distribution of interviewees was partially shaped by a willingness to participate in the research, and whilst it is additionally recognized that the number of interviews is low for a study of this nature, these interviews were designed to complement the extensive literature review for this preliminary study. This is also a relatively new area for academic research, which limited the availability of existing studies covering the topic area (although new publications are consistently being released), and hence it is hoped this paper will provide a foundation for future and further analysis.

Results and discussion

Pathways and barriers to different water futures

Across the region there is a clear lack of any systematic regional approach that looks at water management trade-offs and interdependencies with regards to Chinese activities linked to BRI investments. Across reported and local perspectives there is consensus that, since gaining independence in 1991, the region has struggled in the absence of a viable regional system for sustainable water resource management, leaving a highly fragmented approach that has resulted in each country pursuing unilateral water development projects and causing significant tension across the region (Horsman, 2018; Zhang, 2014b; N2). Despite efforts focused on framing upstream development as benefit sharing, tensions have been recently exacerbated by the commencement of construction of the Rogun Dam, a controversial upstream hydropower dam that would help deliver energy security to Tajikistan, but potentially threaten the water security of downstream nations (Menga, 2015; Suleimenova, 2018).

Whilst amongst the Central Asian states it appears locally compelling to seek improved energy production and food security, differing priorities and an observed lack of enthusiasm for transboundary cooperation has created a challenge for effective transboundary water management (Guo et al., 2016; N2). Official water-sharing agreements exist but are not often inclusive of all the relevant stakeholders or followed by all signatories (Simonov & Egidarev, 2017). A collaborative approach across the national governments, particularly within shared river basins, may help to resolve the numerous transboundary issues and the development of effective water-sharing agreements (Abdullaev & Rakhmatullaev, 2016; J2).

Overall, the proposed BRI envisions integration on seven fronts: transport, energy, trade, information, research and development, agriculture, and tourism (Tracy et al., 2017).

However, water resources and their management currently do not appear to be specifically referenced in any policy documents or proposals relating to the BRI; and the initiative does not have any associated transboundary water cooperation frameworks (Global Water Forum, 2017). Indeed, despite the close involvement of many individuals interviewed and the extensive literature review, the details of the form, scope and delivery of the BRI in this region remain unclear. Instead, Chinese ministries, SOEs, and regional and local authorities are developing localized proposals in response to the broad, overarching concept promoted by the initiative (International Crisis Group, 2017). This may be viewed as an extension of China's previous 'Going Global' policies that emerged at the end of the 20th century and represented an ideological and economic shift from self-reliance to globally outward investment and engagement (China Policy, 2017).

Many of the proposals within the current BRI involve water, including hydropower and dam projects, navigation proposals, agricultural cooperation plans and electricity projects. Recently, China has established several research programmes focused on regional water and environmental issues (Li et al., 2015) and is promoting research collaboration with neighbouring countries (Suocheng et al., 2015). If successfully enacted, this may present an opportunity for increased baseline scientific knowledge and capacity development within the various countries along the route.

China's involvement in water-related issues at a strategic level may be further stimulated through the political and economic dynamics that emerge within the BRI development. China has a hallmark policy of non-interference in domestic politics (Hofman & Ho, 2012; Matthews & Geheb, 2014); however, policy-makers and SOEs are likely to be seriously concerned about domestic socio-political stability (Martens, 2018; Zhang & Li, 2017b) and may be motivated to positively exercise influence and become involved in water diplomacy to diffuse any regional tensions that threaten to derail the BRI proposals (Chugh, 2017). Such hypotheses were echoed by one interviewee, with expectations that China will attempt to drive 'peaceful relationships between countries, to be able to safely invest, both in upstream and downstream countries' (P4). More broadly, the economic integration and cooperation required for delivery of the BRI may also provide an opportunity to stimulate further cooperation on water amongst countries in the region and manage transboundary issues (P1).

This is reflected by recent advocacy by Chinese officials for 'water diplomacy', encompassing closer ties between China and its neighbours with respect to water resources management, while also providing assistance to other countries in dealing with their water issues (A2), with potentially significant implications for water conflicts and water politics in the region (Zhang & Li, 2017a; Murthy & Mendikulova, 2017).

The following sections highlight specific areas of the proposed impact within the BRI that will have an anticipated impact on water.

Infrastructure

Development of linear infrastructure is recognized the backbone of the BRI initiative, with a predominant focus on the current and proposed construction of roads, railways, pipelines and associated infrastructure to increase connectivity along the route (Swaine, 2015). Central Asia is the location of several major Belt routes, including the China–Central Asia–West Asia Corridor, the Eurasian Land Bridge, and the Khorgos–Aktau railway, with additional pipelines, railways, hydropower stations and logistics hubs also in planning or development (Ghiasi & Zhou, 2017). The environmental risks of such linear infrastructure

projects are widely acknowledged, including major negative impacts on soils, hydrology and water ecosystems (Tracy et al., 2017), thereby necessitating careful impact assessment and mitigation practices (Li et al., 2015).

Numerous proposals for linear railways and highways throughout mountainous areas of the region may pose particular concerns associated with design and construction practice (J1). Linear infrastructure construction can have a range of impacts on soil, hydrology and biotic processes upon which ecosystems depend (Raiter et al., 2018). In low rainfall areas, such as the lowland plains in Tajikistan, agriculture is vitally dependant on water transported from glaciated mountains and the high fertility silt it brings down with it, which acts to replenish the soil. Negligent design and construction practices can disrupt transport of water, both above and below the mountain surface, and the critical volumes of silt it brings with it, with the highly detrimental impact to agriculture and communities downstream. Equally, poor construction management, including inadequate removal of excavated fill and waste from construction sites, can be of significant concern due to potential for pollution and habitat damage (J1).

Another key pathway for infrastructure proposals to influence water resources is through the facilitation of virtual water trade along the BRI routes. As a nation, China faces ever increasing challenges with respect to food and water security, encapsulated by the commonly cited statistics that the nation boasts 21% of the world's population while possessing only 8.5% of available arable land and 6.5% of water reserves (Hofman & Ho, 2012). Globally, China is the primary importer of food and is becoming increasingly reliant on global trade in virtual water to ensure ongoing water and food security (Hoff, 2009; McCarthy, 2015). As such, the development of new and enhanced trade routes through the region has the potential to facilitate the greater export of wheat and other staple crops from producing nations, such as Kazakhstan, to China and surrounding areas.

Industry

Industrial development is also understood to be proposed along the new linear routes (J1; A2; N2). Some of this is actively planned, notably including the recent expansion of cement production capacity within Tajikistan (Tracy et al., 2017; Vakulchuck & Overland, 2019; Kohli et al., 2019), whereas other activity is anticipated to naturally follow the newly related transport links (Li et al., 2015). Given the region's abundant land and opportunities for industry and infrastructure development; if resources are not properly allocated, such new industry may also have a substantial impact on water quality and increase levels of water stress (P1). In a context where Central Asia is still facing the environmental legacy of Soviet industry, including radioactive and toxic contamination from close to 60 abandoned uranium sites (scattered throughout rural Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan) and the Semipalatinsk nuclear testing site in Kazakhstan (Green, 2016; Kassenova, 2016), poorly managed industry could aggravate stress on degraded ecosystems.

China has a poor history of environmental management, with rapid industrial growth in its north-eastern provinces and use of agricultural fertilizers and pesticides having already significantly impacted watercourse quality within China and its transboundary rivers (Grumbine & Xu, 2013). In particular, Kazakhstan has long been concerned about upstream watercourse impact (A2), with Chinese water diversion on the Irtys and Ili rivers cited as a major cause of flow decline and subsequent agricultural and aquatic ecosystem impact (Ho, 2017). Similarly, contamination due to heavy metals and oil products from

upstream mining, metallurgical and thermal power enterprises is understood to have contributed to high levels of water pollution (Krasnoyarova et al., 2019). Already, numerous concerns have been raised regarding levels of pollution associated with migration of resource-intensive and often dirty industries and technologies from China into adjacent countries (Simonov & Egidarev, 2017; Tracy et al., 2017).

Hydropower

Hydropower development is a significant area of investment for China, both domestically and globally, and is considered likely to be a key component of BRI delivery in this region (A1). However, this is currently not well defined and is additionally obscured by intense speculation (J1). The Asian Infrastructure Investment Bank (AIIB) has recently invested USD60 million into Phase 1 of the Nurek Hydropower Rehabilitation project in Tajikistan (AIIB, 2017), and it is understood that significant hydropower related loans have been granted to Uzbekistan during the BRI forum (Eurasianet, 2017). Much speculation is present regarding Chinese investment into the Rogun hydropower dam in Tajikistan, a controversial 3600 MW scheme currently under construction (Menga, 2015). However, the consensus from local stakeholders was that direct investment in such a politically charged scheme is unlikely because of a desire for perceived neutrality. Further involvement may be more indirect, such as through the Central Asia South Asia Electricity Transmission and Trade Project (CASA 1000), which will facilitate the export of hydropower to South Asia from Kyrgyzstan and Tajikistan. China has expressed interest in this scheme, which is unlikely to be viable without the construction of additional hydropower capacity, notably including Rogun (P4; A1). The direct contribution to smaller scale schemes in Kyrgyzstan and Tajikistan is considered more likely, particularly as the initiative progresses, creating more demand for energy (A2, N2).

The potential impacts of hydropower on water resources and supported socio-environmental systems are well understood (Middleton et al., 2014; Tilt et al., 2009), and regional hydropower construction has previously resulted in significant ecological damage (Tracy et al., 2017). Therefore, whilst hydropower may present several preferential advantages over the various hydrocarbon or nuclear energy alternatives available and under consideration (Tskhay, 2019), potential downstream impacts remain of concern for many stakeholders. If completed, the Rogun hydropower dam will have a substantial impact on watercourse hydrology in downstream countries, particularly during the initial period of reservoir filling, which will be further exacerbated by hydrological changes anticipated as a result of climate change (Bekchanov et al., 2015). Given China's historical consideration of such issues, numerous stakeholders expressed concerns as to how robustly required levels of environmental and social impact assessment, informed design and comprehensive mitigation might be managed and delivered (A1; A2; N1; N2). In addition to these large-scale hydropower developments, China is also investing heavily in additional energy infrastructure across the BRI. This includes over 48 projects totalling over USD22 billion from small-scale dams to the Central Asia–China gas pipeline that will cost USD7 billion (Aminjonov et al., 2019). The water impacts from all these projects are out of the scope of the analysis of this paper; however, they will undoubtedly have complex costs and benefits and require the management of trade-offs across the region.

Agriculture

Whilst a less-publicized element of the initiative, the BRI will provide abundant opportunities for developing economic and trade cooperation on agriculture. Recently, there appears to be growing recognition of agriculture as a broader component and implication of the BRI (P1). This reflects the evolving and expanding nature of the recognized underlying drivers, which include a range of political, economic and security-related considerations, as well as a notable agenda related to energy and food security (Ghiasi & Zhou, 2017; International Crisis Group, 2017).

China is heavily reliant on global trade and global food security trends, particularly including the export of staple crops from the United States. It is thought that having recognized the strategic risk of overdependence on the United States and associated maritime transport routes (given entrenched historic distrust), China is seeking a diversification of imports and the establishment of additional land-based transport mechanisms, including those proposed under the BRI (Zhang, 2014a; P3). Over coming years, China is anticipated to become increasingly active in securing food sources from other parts of the world through trade, purchase and lease of foreign land, as well as the merger and acquisition of foreign agricultural businesses (Zhang & Li, 2017b).

To facilitate an increasing reliance on virtual water trade, China has developed a strong strategy for agricultural engagement overseas, through which aid, investment and other forms of cooperation are tied together and used to increase global food and agricultural exports (Allan et al., 2012; Zhang, 2019). Central Asia, in particular Uzbekistan, Kazakhstan and Tajikistan, have vast untapped agricultural potential, in addition to facilitating access to further markets in Central and Eastern Europe and Russia. China has already indicated a commitment to promoting rural and agricultural development along the proposed BRI through the delivery of investment, knowledge and technology. By investing in the Central Asian agricultural sector and developing closer food ties with these countries, the BRI can enable new food trade routes and support food security, both locally and through Chinese agricultural import (He et al., 2016; Zhang, 2019; A2). These areas also face key obstacles in farming techniques, inputs, agricultural machinery, transport, infrastructure and storage facilities (Food and Agriculture Organisation of the United Nations (FAO), 2011). If properly implemented, agricultural cooperation – including much needed financial investment, research and development, and new technology – stimulated by the initiative, could provide substantial benefit to the region's food supply and assist in alleviating the current inefficiency and wastage of water resources (Zhang, 2015).

For the regional governments in Central Asia, agriculture is also a key priority area for development, comprising a key element of state programmes and strategies and a critical source of livelihoods and employment for rural people. As such, not only this is likely to be a component of any agreements reached to facilitate the BRI delivery (P2) but also it may form a key priority area, as has already been demonstrated in other areas associated with the BRI, such as the China–Pakistan Economic Corridor (A2). China has already signed the Shanghai Cooperation Organization (SCO) with Mongolia, Russia and Central Asian countries (He et al., 2016), and in 2012, China announced its consideration of a China–Central agricultural cooperation fund and the building of several trade zones and agricultural demonstration centres to promote agricultural development in the region. Following this, in 2013, Xi Jinping addressed a SCO summit in Kyrgyzstan, proposing that SCO countries should establish a cooperation mechanism for food security (Zhang, 2014a). Most recently,

in July 2020, key representatives from China and the Central Asian nations engaged in the Inaugural China–Central Asian Countries Foreign Ministers’ Meeting, resulting in a nine-point consensus on cooperation for peace and development. Amongst these points were commitments to align the BRI and the ‘development strategies of Central Asian countries’ (point 3) and to ‘strengthen agricultural cooperation to ensure food security’ including though ‘more high-quality, green agricultural exports from Central Asian countries’ (Ministry of Foreign Affairs, People’s Republic of China, 2020).

Specific projects and initiatives remain largely unclear; however, local observers consider it likely that Tajikistan and Kazakhstan will be focus areas for this type of development (J1). Alongside a range of multilateral organizations acting in the region (Sehring et al., 2019), there has been significant Chinese investment in cooperative agricultural and water management initiatives. In Kazakhstan, recent engagements include an agricultural park, promoting ‘new technologies associated with water saving and agricultural technologies, new crops [...]’, and Chinese investment in agricultural pumping systems (P1). Similar initiatives have also been observed in Kyrgyzstan, where another Chinese-funded agro-industrial park has been announced (China.org, 2017); and Chinese researchers are undertaking tests using new seeds and drip irrigation in areas of Tajikistan (A3). In September 2017, China and Tajikistan signed a package of agreements focusing on cooperation across numerous spheres, with a focus on agriculture and technology (Baijie, 2017). Under these agreements, export of technology and knowledge is anticipated to play a large role in agricultural delivery under the BRI, including improved cultivation practice, new seed and plant varieties, and the exchange of agricultural technologies (Chugh, 2017).

Given the previously highlighted issues of resource mismanagement, this has the potential to bring immense benefits to the region through the delivery of economic and technological investment and the sharing of agricultural knowledge and expertise in water resources management (Li et al., 2015, p. 2). There is much focus on poor efficiency attributed to the deteriorating irrigation infrastructure (N2), providing substantial opportunity for Chinese investment (Chugh, 2017). China’s Xinjiang province, which will be closely linked to Central Asia through the BRI, possesses advanced knowledge and technologies in terms of improving irrigation efficiency and tackling issues of salinization. Through export of technologies or assistance in upgrading irrigation infrastructure, water-use efficiency by the agricultural sector could be improved as a whole (A2), building on previous highly successful initiatives (N1).

Additionally, currently cultivated crop varieties are often not well suited to the different country environments within this region, partially attributed to each country seeking independent and total agricultural self-sufficiency, high-value crop production and Soviet-era crop choice as determined by central governments (e.g., the requirement for many in the region to grow water-intensive cotton) (Karthé et al., 2014; Ziganshina, 2009). Therefore, by stimulating regional cooperation and opening new trade routes, the BRI could allow countries to achieve closer agricultural food trade and optimize crop selection and distribution in accordance with water availability, potentially improving levels of water stress across the region (A2).

However, these potentially positive impacts and the extent of their distribution will be dependent to a large extent on how the initiative is delivered. In addition to the facets of the BRI focused on agricultural cooperation, there is also substantial direct investment in agriculture by Chinese companies, both private and state owned (Hofman, 2016; Long,

2017; Zhang, 2014b). Tajikistan and Kazakhstan have been particularly targeted through this strategy. In 2011, the Chinese government secured a deal with the Tajik government for the leasing of 110,000 hectares of agricultural land (equivalent to 1.0% of Tajikistan's total land area), stimulating international debate (Squires, 2018). In Kazakhstan, Chinese companies also have a large presence in the country's agricultural sector, including investment in soybean production covering a reported 1 million hectares (Zhang, 2014a). Local benefit in terms of improved practice may be more limited under these scenarios, particularly as Chinese companies also regularly dispatch their own labour force, limiting demand for local employment (Squires & Feng, 2020; Victor, 2018), and there is also a risk of the overexploitation and degradation of water resources (Hoff, 2009).

The initiatives focused more on cooperation and agricultural development are not necessarily directly related to this second type of agricultural investment, although they are likely to be supported by the state at a strategic level. Direct agricultural investment is likely to be motivated by economic drivers, with companies typically investing in overseas agriculture due to Chinese domestic labour surplus, and therefore seeking an unsaturated market (A3). However, such investment 'may actually be intermingling with the political goals associated with agricultural cooperation' (A3), such as 'soft' influence to encourage loyalty or to decrease local discontent and regional security concerns (International Crisis Group, 2017). This also aligns with China's aforementioned motivation to actively develop agricultural production in neighbouring countries because it is advantageous for protecting China's own food security (Zhang & Li, 2017b).

Across both forms of investment, there is also a serious risk associated with introducing new technologies into areas with well-established agricultural practices and without enabling institutional frameworks that provide capacity development and financing support for wide-scale adoption, as well as taking a systems approach to understand sustainability and environmental impacts. Paradoxically, the historic delivery of innovative technology proposed by foreign donors in this region has rarely and only partially succeeded for this reason (Chatalova et al., 2017). Recent efforts have focused on challenging the rehabilitation and maintenance of dilapidated Soviet-era irrigation systems (Xenarios et al., 2019). However, whilst successfully increasing agricultural production, such efforts may also directly lead to higher water consumption and associated levels of water stress (Lankford et al., 2016; Perry, 2007).

Social, environmental, and political implications and mitigation

The social, environmental and political implications of any impacts to water resources in this region will potentially be profound (Zou et al., 2019). Across the region, the disproportional distribution of water and natural resources already forms a source of political tension (Li et al., 2015), which has previously led to violent clashes involving water (Howard & Howard, 2016). There is substantial publicity given to these regional political tensions, which is frequently highlighted amongst the risks both to and from the BRI. However, several respondents expressed scepticism regarding the ongoing rhetoric regarding escalating tensions and the possibility of a 'water war' (A1). The recent transition of leadership in Uzbekistan was also broadly viewed as a positive sign towards improved dialogue, cooperation and consensus regarding water resource use (P2; P3). Respondents' perceptions of the extent to which the BRI might impact on water-related

tensions were varied; however, generally there appears to be a risk to regional relationships and the level of current tensions, particularly associated with more controversial hydropower or water diversion projects.

Further political collaboration on water resources to address issues of distribution and transboundary management would be of significant benefit from a socio-environmental perspective. The region is recognized as being of high value in terms of biodiversity and species endemism (CEPF, 2017) and recent spatial mapping exercises have highlighted the high levels of risk to water-related ecosystem services across Central Asia (World Wildlife Fund (WWF), 2017). Ecologically, the area is unique due to its intactness and very low level of fragmentation, although this is already threatened by degradation due to unmitigated impacts of industrial development. As such, there are concerns that the environmental flows may be disrupted due to water overuse and regulation which, following the precedent of the Aral Sea crisis, could have a very serious impact on biodiversity, including individual species, species distribution and potential desertification (Xu, 2017; N1; N2). Such impacts could be particularly severe considering potential climate scenarios; they are predicted to increase variability of annual snowfall and water runoff, thereby impacting local rivers and aquatic ecosystems (Punkari et al., 2014; Reyer et al., 2017).

Particular concerns have also been raised due to the granting of land concessions to Chinese investors, with limited associated regulation or enforcement regarding water resources use. Investors have been previously observed drawing extensive water from irrigation canals, with a detrimental impact to environmental flows and local agricultural practice (N1). Such an unregulated approach has the potential to cause severe environmental damage and may also raise concerns about the occupation of land that might have previously been available to local subsistence farmers.

Water pollution in the region is another potential environmental issue. Domestically, China is actively pursuing the greening of its own economy; however, the extent to which this will translate to international endeavours is still unclear (Tracy et al., 2017). Some observers have highlighted a risk that this green shift may be partially achieved through the export of polluting industries and the degradation of natural resources to countries at a lower position in the global production chain (Matthews & Motta, 2015; A3). One potential example of this is in environmental degradation associated with the expansion of cement production capacity in Tajikistan, which may have a substantial impact on local communities relying on these water resources.

Large-scale infrastructure schemes have possibly the most significant potential for substantial social and environmental impact, and accordingly, assessment and mitigation of impacts are highlighted as key concerns (World Commission on Dams (WCD), 2000). Many local communities in this region rely on subsistence agriculture with limited resilience to change, and they may be heavily impacted by these schemes, potentially forced to resettle and subsequently losing access to local ecosystem services. Such social impacts are likely to vary widely, reflecting the heterogeneous nature of communities and possible trajectories of delivery. However, positive impacts are also likely where local agricultural communities are empowered, with development assistance potentially leading to improved productivity and opening new trade routes and markets for local producers, provided the scale and direction of delivery reflects local needs in terms of connectivity.

Agricultural cooperation, including improved practice, an investment-stimulated increase in cultivated area, and a greater variety of crop production have also the

potential to bring wider economic and food security benefits to the general population (Amirova et al., 2019; Zhang, 2014b), but much will depend on the uncertainty of markets and climate change and the sustainable management of water resources. Considering the broader picture of economic stimulation brought about by the initiative, the extent to which benefits will be redistributed to local populations is unclear, with expectations amongst observers varying from highly optimistic to very sceptical, particularly considering the influence of local government corruption with benefit historically 'redistributed at the top', leaving little to trickle to the 'lower levels of the social hierarchy' (A1).

Whilst all infrastructure works are likely to have some social and environmental impacts, there is a question about the extent to which proper impact assessment and mitigation will be undertaken by either the state or investors. This was a key theme across the majority of interviewees, who described a consideration for environmental and social impacts as simply 'not a priority' for either party, including both policy-makers and local populations, driven predominately by financial outcomes (J1). This is further exacerbated by the 'absence of good policy frameworks', a 'low rate of law enforcement' and levels of corruption (N2). Therefore, robust safeguards 'are simply not in place' in developing countries with scarce and weakly enforced regulation on EIA (Tracy et al., 2017; N2).

Typically, Chinese investment has less conditionality associated with environmental or social standards as compared with many Western counterparts (Matthews & Motta, 2013; Siciliano & Urban, 2017), echoed by their hallmark policy of non-interference (Hofman & Ho, 2012). Furthermore, Chinese developers do not have a good reputation with regard to social and environmental impact management when investing in infrastructure abroad (Kirchherr & Matthews, 2018), although there are signs that learnings from projects such as the Myitsone Dam in Myanmar (Kirchherr et al., 2017) are being recognized. Within this context, it was generally considered unlikely that the Chinese will be inherently motivated to implement robust or expensive mitigation processes, unless these are directly required. As such, it is critical that the drive for sustainable development 'comes from the local governments' through which the BRI is passing (N1). As demonstrated through their 'Ecological Civilization' framework of environmental policies (Hansen et al., 2018), China is developing much more robust domestic processes for environmental management which could be applied to international contexts (Simonov & Egidarev, 2017), potentially facilitating capacity-building, knowledge transfer and best-practice impact mitigation. However, the eagerness of the recipient governments to apply such pressure was also judged uncertain due to additional complexity and the costs associated with more regulated project development (N2). Efforts at environmental mitigation will be additionally particularly challenging in this region due to the inherent complexity of the natural system, scarcity of scientific data and existing regional tensions (Howard & Howard, 2016).

It is possible that the delivery of large infrastructure projects under the BRI, and associated involvement of diverse and prominent stakeholder groups, will also assist to stimulate the development of more robust development policy tools and frameworks in the region, as occurred in the Mekong Basin (Motta & Matthews, 2018). In particular, this may occur through a dialogue with international institutions and financial lenders who are likely to require increased regulation and safeguards (N2), or by access to green technology and green finance mechanisms, as currently promoted by China domestically (Tracy et al., 2017). Furthermore, the enormous scale of the initiative is anticipated to play a role in developing scientific knowledge and raising awareness in an area where it is

currently somewhat scarce (N2). Increased regional cooperation may also provide a key opportunity to 'join forces in terms of conservation', leveraging off China's substantial research and management capabilities (P3). The role of civil society, international and local organizations in monitoring the implementation processes was emphasized by several respondents. Already, a 'developing coalition' of organizations is emerging 'on both sides, the Chinese and International', engaging with and monitoring development along the BRI (P3).

Within the region there are clear benefits from the greater involvement of stakeholders and using an integrated approach to determine how to improve water governance. As one local observer reflected:

it will not be done by the countries of the national governments, unless they are really, really pushed to it by the civil society, by academics, by think tanks, by the media and most importantly the people who actually live on the banks of these rivers and have to use these integrated approaches every day. (J2)

However, it must also be noted that the current authoritarian regimes do not allow space for governance shifts and may not encourage freedom for advocacy from individuals and stakeholder groups. Equally, whilst delivering integrated approaches would undoubtedly be of substantial benefit, this was also highlighted as extremely difficult to deliver within this region due to substantial complexities across realms of geography, climate, political context and economic interests, creating a highly dynamic and 'multi-layered' system (P3). Within this context, balancing numerous objectives including 'multi-stakeholder involvement, public participation [...] water resources needs and also environment, social and economic needs' is extremely challenging (A2). This will clearly be an enormous challenge and raises questions about the relationships between democracy, water governance and social power, as to the extent to which such truly integrated approaches can be delivered within the current context (Swyngedouw, 2009).

Conclusions and recommendations

If carefully planned and sustainably delivered, the vast economic corridors and infrastructure networks delivered by Chinese actors across the proposed BRI have the potential to deliver enormous positive outcomes for its neighbours in Central Asia (Collins, 2020). Whilst water-related aspects of the initiative (including hydropower and dam projects, navigation proposals, agricultural cooperation plans and electricity projects) are not as strongly emphasized in currently published information, propaganda or local discourse, these are likely to form important aspects.

During the last two decades, China's overseas activities have generally taken a policy of non-interference in external affairs and, as such, its investment and loans are typically delivered with 'no strings' in terms of environmental and social standards (Tracy et al., 2017). The lack of consideration or mitigation of trade-offs associated with Chinese investments has already been demonstrated in other regions (Motta & Matthews, 2018; Urban et al., 2015). Given the deep interconnections across water, food and energy in this region, and in order to ensure sustainable water resource management, China will need to support jointly pursued economic development plans and an integrated approach to

water management to ensure that investments in one sector and country do not undermine parts of the initiative in other sectors or countries (Simonov & Egidarev, 2017).

This early review of the BRI raises some significant concerns regarding how trade-offs will be managed. Greater visibility of the project proposals in this region, including a clear picture of the objectives and implementation strategy, are needed. Establishing a sufficiently detailed and long-term plan will be essential to identify the winners and losers from the trade-offs of these developments. Equally, processes of transparency and regulation will be key throughout all phases of project delivery and must be established early in the programme. China's record on transparency and sustainability in projects abroad has not been without criticism; however, there are signs this is changing as Chinese SOEs learn from past challenges (Kirchherr & Matthews, 2018; Kirchherr et al., 2017). Early engagement of regional stakeholders will additionally be critical by opening dialogue and establishing platforms for regional cooperation. There is a prominent need for development of scientific data and involvement of research institutions. Specific information gaps already identified include baseline environmental and hydrological data, the identification of critical hotspot areas, estimates of initiative water and energy demands (including the evaluation of transboundary waters), and the full assessment of the potential environmental and social impacts (Howard & Howard, 2016). There is a critical role for civil society and international organizations in engaging with the initiative to influence delivery, including the provision of expertise, monitoring delivery and advocating for robust mitigation. However, the degree to which civil society will be allowed to operate freely and advocate for the environment and communities across the region is uncertain. Generally, governments along the BRI tend to tightly control any activities, secular or religious, that might pose political threats, creating a clear risk that certain perspectives may be sidelined and socioeconomic considerations discounted in favour of economically or politically favourable outcomes. However, as the countries of Central Asia forge ahead with a hybrid path between capitalist and socialist systems, there are increasing opportunities for voices to be heard and for good water governance to emerge (Buxton, 2011; Schmidt & Matthews, 2017).

The adoption of meaningful social and environmental safeguards and standards in the initial planning stages of development is fundamental. As a minimum, these need to align with domestic standards under China's Ecological Civilization policies, and ideally be based on accepted international standards. It is essential that these be uniformly delivered across all projects considered beneath the BRI, regardless of the specific delivery body. Given the complex hydro-social landscape, delivery of robust and contextualized environmental and social impact assessment, consultation and monitoring processes will be essential to shaping overall development outcomes. While such impact assessments may be framed according to scientific principles, the issues they address are subject to many political and financial conditions that significantly affect their implementation. Therefore, their value in identifying and mitigating the impact and risks associated with BRI development is limited by how much they are protected from interference, such as corruption or political wrangling within the region. The degree to which impact assessments will be effective tools to identify and mitigate risks in across the BRI remains to be seen.

Agricultural cooperation is one of the key areas of the initiative with the potential to provide an opportunity for the improvement of local practice and a direct benefit to local populations; however, this will require highly sensitive delivery. Any projects will need to be

actively driven by local partners in order to manage the long-term sustainability of interventions motivated by external factors from the Chinese side. Any interventions must engage closely with communities and producers, maintain the required local employment standards, and be carefully tested and sufficiently regulated in delivery. Holistic consideration must be given to potential broader implications, with a particular reference to the numerous uses and values of water to food security, the environment, energy, local communities and, in particular, the interconnectedness of hydrological systems. Solutions will also need to be regionally integrated and encourage closer cooperation across the various Central Asian states.

One of the significant challenges will be developing effective transboundary cooperation amongst states. A fundamental objective for the delivery of greater regional integration through the BRI would be for the establishment of water-sharing agreements associated with the transboundary surface and groundwater resources in Central Asia, including those shared with China. In order for this to be effective, it would need to be supported by robust regional management organizations incorporating all stakeholders (notably including China), as demonstrated through previous efforts in the Mekong River (Armitage et al., 2015). Whilst this could significantly change the environment with respect to water cooperation, it represents a much more challenging and longer term goal. Currently, there is no adequate political will amongst those in power, thereby requiring a radical and seemingly unlikely shift, given the resilience of existing political systems and heads of state. Equally, it is difficult to see how the numerous risks and issues attributed to the current levels of corruption may be remedied without a significant shift in the existing authoritarian regimes.

The pathways and barriers to an integrated approach along the BRI are diverse and tightly wrapped in political, environment, economic, social and historical considerations. The above recommendations are not exhaustive; however, the authors believe that, if implemented, they would significantly increase the opportunities for sustainable regional water management to be delivered through this initiative. Conversely, if delivery is not carefully planned and managed, the history of the region's unintegrated resource management demonstrates that unsustainable development has a limited and costly lifespan.

Acknowledgments

Sincere thanks to all the experts and stakeholders who so graciously volunteered their time and perspectives during this research. Many thanks also to the team at IWC for their assistance and support.

Disclosure statement

There is no potential conflict of interest reported by authors.

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