

24

Asia Supplementary Material

Coordinating Lead Authors:

Yasuaki Hijioka (Japan), Erda Lin (China), Joy Jacqueline Pereira (Malaysia)

Lead Authors:

Richard T. Corlett (China), Xuefeng Cui (China), Gregory Insarov (Russian Federation), Rodel Lasco (Philippines), Elisabet Lindgren (Sweden), Akhilesh Surjan (India)

Contributing Authors:

Elena M. Aizen (USA), Vladimir B. Aizen (USA), Rawshan Ara Begum (Bangladesh), Kenshi Baba (Japan), Monalisa Chatterjee (USA/India), J. Graham Cogley (Canada), Noah Diffenbaugh (USA), Li Ding (Singapore), Qingxian Gao (China), Matthias Garschagen (Germany), Masahiro Hashizume (Japan), Mammohan Kapshe (India), Andrey G. Kostianoy (Russia), Kathleen McInnes (Australia), Sreeja Nair (India), S.V.R.K. Prabhakar (India), Yoshiki Saito (Japan), Andreas Schaffer (Singapore), Rajib Shaw (Japan), Dáithí Stone (Canada/South Africa /USA), Reiner Wassman (Philippines), Thomas J. Wilbanks (USA), Shaohong Wu (China)

Review Editors:

Rosa Perez (Philippines), Kazuhiko Takeuchi (Japan)

Volunteer Chapter Scientists:

Yuko Onishi (Japan), Wen Wang (China)

This chapter on-line supplementary material should be cited as:

Hijioka, Y., E. Lin, J.J. Pereira, R.T. Corlett, X. Cui, G.E. Insarov, R.D. Lasco, E. Lindgren, and A. Surjan, 2014: Asia – supplementary material. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Available from www.ipcc-wg2.gov/AR5 and www.ipcc.ch.

Table SM24-1 | Summary of key observed past and present annual mean temperature trends in Asian countries/territories.

Sub-region	Country/territory	Unit	Change	Period	Reference
Central Asia	Kazakhstan	°C decade ⁻¹	+0.31	1936–2005	Kryukova et al. (2009)
	Kyrgyzstan	°C	+1.6	1901–2000	Iliasov et al. (2003)
	Tajikistan	°C decade ⁻¹	+0.1 to +0.2	1940–2005	Karimov et al. (2008)
East Asia	Hong Kong	°C decade ⁻¹	+0.12	1885–2008	Ginn et al. (2009)
			+0.16	1947–2008	
			+0.27	1979–2008	
	Japan	°C century ⁻¹	+1.15	1898–2010	JMA (2011)
			0.09 ± 0.017	1900–2006	Li et al. (2010)
	China	°C decade ⁻¹	0.26 ± 0.032	1954–2006	
			0.45 ± 0.13	1979–2006	
		°C decade ⁻¹	+0.03 to +0.120	1906–2005	Ren et al. (2012)
			+0.03 to +0.120	1908–2007	
	South Korea	°C	+1.87	1908–2008	Kim et al. (2010)
			+1.37	1954–2008	
			+1.44	1969–2008	
	Taiwan	°C decade ⁻¹	+0.14	1911–2009	Hsu et al. (2011)
			+0.19	1959–2009	
			+0.29	1979–2009	
North Asia	Mongolia	°C	+2.14	1940–2005	Dagvadorj et al. (2009)
	Russia	°C	+1.29	1907–2006	Anisimov et al. (2008a)
			+1.33	1976–2006	
South Asia	Afghanistan	°C	+0.6	1960–2008	Savage et al. (2009)
		°C decade ⁻¹	+0.13	1960–2008	
	Bangladesh	°C decade ⁻¹	+0.097	1958–2007	Shahid (2010)
	India	°C	+0.56	1901–2009	Attri and Tyagi (2010)
		°C century ⁻¹	+0.68	1880–2000	Lal (2003)
		°C yr ⁻¹	+0.0056	1948–2008	Ganguly (2011)
	Nepal	°C yr ⁻¹	+0.06	1977–1994	Shrestha et al. (1999)
	Pakistan	°C	+0.57	1901–2000	Chaudhry et al. (2009)
			+0.47 ± 0.21	1960–2007	
			+0.099	1960–2007	
	Sri Lanka	°C yr ⁻¹	+0.005 to +0.035	1961–2000	Iqbal (2010)
		°C decade ⁻¹	+0.3 to +0.93	1869–2007	De Costa (2008)
			+0.75 to +0.94	1910–2007	
Southeast Asia	The Philippines	°C	+0.648	1951–2010	PAGASA (2011)
		°C yr ⁻¹	+0.0108	1951–2010	
West Asia	Armenia	°C	+0.85	1935–2007	Gabrielyan et al. (2010)
Tibetan Plateau		°C (°C decade ⁻¹)	+1.8 (+0.36)	1961–2007	Wang et al. (2008)
		°C decade ⁻¹	+0.447	1970–2001	Xu et al. (2008)

Table 24-SM-2 | Summary of key observed past and present annual mean precipitation trends in Asian countries/territories.

Sub-region	Country/territory	Change	Period	Reference
Central Asia	Kazakhstan	No definite national trend	1936–2005	Kryukova et al., 2009
	Kyrgyzstan	+23 mm (+6%)	1901–2000	Iliasov et al., 2003
	Tajikistan (plains region)	+8% (insignificant)	1940–2005	Karimov et al., 2008
	Tajikistan (mountainous region)	-3% (insignificant)		
	Turkmenistan	+12 mm decade ⁻¹	1931–1995	MNPT, 2000
East Asia	Hong Kong	+25 mm decade ⁻¹	1885–2008	Ginn et al., 2009
	Japan	No clear trend	1898–2008	MEXT et al., 2009
	South Korea	+5.6%	2001–2008	Kim et al., 2010
North Asia	Mongolia	-0.1 to -2.0 mm yr ⁻¹	1940–2005	Dagvadorj et al., 2009
	Russia	+7.2 mm decade ⁻¹	1976–2006	Anisimov et al., 2008a
South Asia	Afghanistan	-0.5 mm month ⁻¹	1960–2008	Savage et al., 2009
		-2% decade ⁻¹		
	Bangladesh	+5.53 mm yr ⁻¹	1958–2007	Shahid, 2010
	India	No significant national trend	1901–2009	Attri and Tyagi, 2010
	Pakistan	+61 mm	1901–2007	Chaudhry et al., 2009
		-156 mm	1901–1954	
		+35 mm	1955–2007	
	Sri Lanka	-1.55 to -19.06 mm yr ⁻¹	1961–2000	Iqbal, 2010
Southeast Asia	Indonesia, Brontas Catchment	-1.23 to -24.25 mm yr ⁻¹	1955–2005	Aldrian and Djamil, 2008
West Asia	Armenia	-6%	1935–2007	Gabrielyan et al., 2010
Tibetan Plateau		+0.614 mm yr ⁻¹	1961–2001	Xu et al., 2008

Table SM24-3 | Summary of projected changes in temperature (T) and precipitation (P) across sub-regions of Asia.

Sub-region	Projected changes	
Central and North Asia (see Section 14.8.8 of WGI AR5)	T	<ul style="list-style-type: none"> Central: Similar warming magnitude in winter and summer Northern: Stronger warming trend than the global mean trend during winter
	P	<ul style="list-style-type: none"> Central: <i>Likely</i> increase Northern: <i>Very likely</i> increase Central and Northern: <i>Likely</i> increase in extremes
East Asia (see Section 14.8.9 of WGI AR5)	T	<i>Very likely</i> longer-duration, more intense, and more frequent heat waves/hot spells in summer and <i>very likely</i> decrease in frequency of very cold days
	P	<p>Increase in summer precipitation over East Asia with an intensified East Asian summer monsoon (<i>medium confidence</i>)</p> <p><i>Likely</i> increase over East Asia during the Meiyu–Changma–Baiu season in May to July and <i>very likely</i> increase in extremes over the eastern Asian continent in all seasons and over Japan in summer under the RCP4.5 scenario (<i>low confidence</i>)</p>
West Asia (see Section 14.8.10 of WGI AR5)	T	<i>Very likely</i> that temperatures will continue to increase
	P	Overall reduction (<i>medium confidence</i>)
South Asia (see Section 14.8.11 of WGI AR5)	T	Increase (<i>high confidence</i>)
	P	Increase in summer monsoon precipitation (<i>medium confidence</i>)
Southeast Asia (see Section 14.8.12 of WGI AR5)	T	<i>Very likely</i> increase with substantial subregional variations
	P	<p>Moderate increase in rainfall, except on Indonesian islands neighboring the southeastern Indian Ocean (<i>medium confidence</i>)</p> <p>Strong regional variations because of terrain</p>

Table SM24-4 | Summary of key observed past and present climate change impacts in Asia.

Sub-region	Country or territory	Area	Parameters	Observed changes	Period	References
Central Asia	Kazakhstan	Steppe region in north	Normalized Difference Vegetation Index	Decline (browning)	1982–2008	De Jong et al. (2012)
		Northern Tien Shan Mountains	Permafrost temperature at depths of 14–25 m	+0.3°C to +0.6°C	1974–2004	Marchenko et al. (2007); Zhao et al. (2010)
			Active layer thickness	+23%		
	Uzbekistan	Zerafshan River Basin	Monthly water discharge	Significant increases in spring and decreases in summer	1923–2006	Olsson et al. (2010)
East Asia	China	Kazakhstan, Uzbekistan, Kyrgyzstan	Main lakes	<ul style="list-style-type: none"> • -75.70% (Aral Sea) • -2.61% (Balkhash) • -8.37% (Ebinur) • +0.66% (Issyk-Kul) • +5.85% (Zaysan) • -9.18% (Bosten) 	1975–2007	Bai et al. (2012)
		East Asia north of 23°N	Tree growth	Tree-ring data suggests recent summer temperatures have exceeded those for warm periods of similar length over the past 1210 years.	800–2009	Cook et al. (2013)
		Japan	Multiple sites	Spring leafing and flowering	Earlier by <3 days per decade	Last 60 years
				Species distributions	Northward by <126 km per decade	Last 50–70 years
			Seas around Japan	Species distributions	Northward expansion of fish, corals, and algae	Recent decades
		Shiyang River Basin	Streamflow	Five of eight catchments showing significant decreasing trends	1950–2005	Ma et al. (2008)
			Runoff	No significant change. Clear increasing trend at two of three stations in low-flow period	1956–2000	Liu, D. et al. (2010)
			Tarim River Basin	Streamflow	Three of four rivers with increasing streamflow except Aksu River	1960–2005
				Mainstreams' runoff	Decreased by 41.59% (1970s), 63.77% (1980s), 75.15% (1990s)	1957–2003
				Runoff	In 1990s, runoff from headwaters of Aksu and Yarkand Rivers increased by 10.9%.	1955–2000
			Runoff	Decreased by 1.88% per year, decreasing from 1960s	1950–2000	Wang et al. (2010)
			Upper reaches of Tarim River Basin	Runoff	Aksu River showed a significant increasing trend by 10.9%. Three of four rivers showed an increasing trend with one showing a subtle reduction.	1958–2004
			Laohahe River Basin	Runoff	Runoff in 1980–2008 decreased by 36% compared with 1964–1979	1964–2008
			Hun-Tai River Basin	Streamflow	Downward trends	1961–2006
			Kaidu River Basin	Runoff	Increasing with rate of 8.4 mm decade ⁻¹ ; 1994–2009 increased 26.4% compared to 1960–1993	1960–2009
			Haihe River Basin	Runoff	Significant downward trends	1957–2000
			Pearl River, Yangtze River, Yellow River, Liao River, Songhua River	Runoff	<ul style="list-style-type: none"> • Increased by 10% (Pearl River) • Little change (Yangtze River) • Decreased by 80% (Yellow River) • Decreased by 54% (Liao River) • Decreased by 14% (Songhua River) 	1951–2000
		Qinghai–Tibetan Plateau	Active layer thickness along Qinghai–Tibetan Highway	Mean rate of +7.5 cm yr ⁻¹	1995–2007	Wu and Zhang (2010)
			Position of lower altitudinal limit of permafrost in north	Moved up by 25 m	Last 30 years	Cheng and Wu (2007); Li et al. (2008)
			Position of lower altitudinal limit of permafrost in south	Moved up by 50–80 m	Last 20 years	
			Total area of glaciers of Qinghai–Tibetan Plateau and surrounding areas	Decreased by c. 9%, from 13363 ± 668 km ² to 1213 ± 607 km ²	1970s–2000s	Yao et al. (2012)
	Whole country	Start of plant growth in spring	Earlier start by c. 2 days per decade	Last 30 years	Table SM24-6	
	Most rice production areas	Rice yield	Positive correlation to temperature	1981–2005	Zhang, T. et al. (2010)	
Taiwan	Mountains	Plant distributions	Upper limits shifted upwards by 3.6 m per year	1906–2006	Jump et al. (2012)	

Continued next page →

Table SM24-4 (continued)

Sub-region	Country or territory	Area	Parameters	Observed changes	Period	References
North Asia	Mongolia	Kherlen River Basin	Underground water storage	No evidence for long-term storage change	1947–2006	Brutsaert et al. (2008)
		Khentey Mountains	Growth of Siberian larch forest in forest-steppe ecotone	• Tree-ring analysis shows a decreasing annual increment. • Regeneration of larch decreased.	1940s–2010	Dulamsuren et al. (2010a,b)
		Hovsgol mountain region	Mean annual permafrost temperature at 10 m depth	Increased on average by 0.02–0.03°C year ⁻¹	Last 10–40 years	Sharkhuu et al. (2008); Zhao et al. (2010)
		Hangai and Khentey mountain regions	Mean annual permafrost temperature at 10 m depth	Increased on average by 0.01–0.02°C year ⁻¹		
	Russia, east of Urals	Siberia	Forest-tundra ecotone	• Larch stands crown closure, and larch invasion into tundra at a rate of 3–10 m year ⁻¹ • Shrub expansion in arctic tundra as result of an increase in shrub growth	1970–2000	Kharuk et al. (2006); Myers-Smith et al. (2011); Blok et al. (2011)
			Distribution of dark needle conifers, Siberian pine, spruce, and fir	Invasion of dark needle conifers and birch into larch habitat	1980–2010	Kharuk et al. (2010a,b); Osawa et al. (2010); Lloyd et al. (2011)
			Permafrost temperature at zero annual amplitude	Warming of permafrost in most permafrost observatories in Asian Russia by 0.5–2°C	1970s–1990s	Romanovsky et al. (2008), with supplement; Romanovsky et al. (2010)
		Asian Arctic		No significant warming	2000–2007	
				Warming of permafrost resumed at many locations, predominantly near Arctic coasts	2007–2008	
			Average erosion rate of coastline	0.27–0.87 m year ⁻¹	Second half of 20th century	Lantuit et al. (2012)
	Kodar Mountains	Ural Mountains	Area of glaciers	Decreased by 20–30% in total	1953–1981	Anisimov et al. (2008b)
		Kodar Mountains	Area of glaciers	Exposed ice area declined by c. 44%.	ca. 1963–2010	Stokes et al. (2013)
				Exposed ice area declined by c. 40%, from $11.72 \pm 0.72 \text{ km}^2$ to $7.01 \pm 0.23 \text{ km}^2$.	1995–2010	
		Suntar-Khayata Range	Area of glaciers	Decreased by 19.3%	Mid-20th century–2003	Ananicheva et al. (2005, 2006)
		Chersky Range	Area of glaciers	Decreased by 28%	1970–2003	Anisimov et al. (2008b)
	South Asia	Kamchatka	Area of glaciers	Decreased for some glaciers, increased for others	Since mid-19th century	
		Upper Indus Basin	Water stress	No strong evidence for marked reduction in water resources	1961–2004	Archer et al. (2010)
		Headwater of Kosi River	Water resources	Reduction in groundwater recharge, 36% of springs have dried, heads of perennial streams have dried, and water discharge in springs and streams has decreased considerably.	1990–2010	Tiwari and Joshi (2012)
		Andaman Islands	Coral health	Mass bleaching	2010	Krishnan et al. (2011)
	Nepal	Himalayan region	Water resources	Significantly moving snowline	1961–1998	Karki et al. (2009)
		Shorong, Khumbu, Langtang, Dhaulagiri, Kanchenjunga	River discharge	Decreasing trend in Karnali and Saptakoshi; increasing trend in Narayani. No trend in southern rivers	1970s–2000s	Shrestha and Aryal (2011)
	Pakistan, India, Nepal, Bhutan	Himalayas	Start of plant growth in spring	Earlier start by 1.9 days per decade	1982–2006	Shrestha et al. (2012)
	All countries	Whole area	Livelihoods	Leave farming due to repeated droughts	Last few decades	Kulkarni and Rao (2008)

Continued next page →

Table SM24-4 (continued)

Sub-region	Country or territory	Area	Parameters	Observed changes	Period	References
Southeast Asia	Indonesia	Province of Papua	Area of mountain glaciers Puncak Jaya, Central Cordillera, New Guinea Island	Reduced from 19.3 km ² to 7.3 km ² (mid-19th century–1972), reduced from 7.3 km ² to 2.1 km ² (1972–2002)	Mid-19th century–2002	Prentice and Glidden (2010); Allison (2011)
	Malaysia	Mount Kinabalu, Sabah	Altitudinal distributions of moth species	Uphill shifts by average 83 m (upper) and 86 m (lower)	1965–2007	Chen et al. (2011)
	Indonesia, Malaysia, Singapore		Coral health	Mass bleaching and subsequent mortality	2010	Guest et al. (2012)
West Asia	Jordan		Wheat and barley yield	In 1999, total production and average yield for wheat and barley were lowest among years due low rainfall, which was 30% of average.	1996–2006	Al-Bakri et al. (2010)
	Azerbaijan, Georgia	Southern flank of Greater Caucasus Range	Area of glaciers	Decreased by 31.2% in total	1895–2000	Anisimov et al. (2008b)
	Iran, Iraq, Kuwait, Qatar, Saudi Arabia, United Arab Emirates		Coral health	Mass bleaching and subsequent mortality	1996–2012	Coles and Riegl (2013)
Kazakhstan, Kyrgyzstan, Tajikistan, China, Mongolia, Russia (east of Urals), Afghanistan	Altai–Sayan, Pamir, and Tien Shan Mountains	Area of glaciers	Decreased on average by 10%	1960–2009	Aizen (2011); Aizen et al. (2006, 2007)	
		Ice volume of glaciers	Decreased on average by 15%			
East and South Asia		Poverty	Disproportionately impacted by climate-related hazards	1970s–2000s	Kim (2012)	
East and Southeast Asia	Mekong region	Livelihoods	Increased migration due to environmental (e.g. rapid-onset disasters), social, and economic reasons	Over past four decades	Warner (2010); Black et al. (2011)	

Table SM24-5 | Summary of key projected climate change impacts in Asia.

Sub-region	Country or territory	Area	Parameters	Projected impacts		Scenario	GCM (RCM)	Period	Base year	Reference
Central Asia	North and east Kazakhstan		Crop yield (cereal)	Benefit from longer growing season, warmer winters and slight increase in winter precipitation						Liubimtseva and Henebry (2009)
West Turkmenistan and Uzbekistan			Crop yield (cotton)	Negative impacts from frequent droughts						
East Asia	Japan	Tohoku and Hokuriku	River discharge	200% higher in February, 50 to 60% lower in May		A1B	AGCM	2080–2099	1980–1999	Sato, Y. et al. (2012)
			Rice transplanting date	Northward shift of isochrones of safe transplanting dates		A2	MRI-CGCM2 (RCM20)	2081–2100	1971–2000	Ohta and Kimura (2007)
China	Tarim River Basin	Flow	Positive change of 1.3 to 12.8% in BYBLK and 17.7 to 29.7% in DSK		A2, A1B, B1	18GCMs	2046–2065	1979–1998	Liu et al. (2011)	
	Poyang Lake	Annual catchment inflow	Increased by 2.9% (A1B) and 6.5% (B1), decreased by 5.2% (A2).		A1B, B1, A2	ECHAM5	2011–2050	1961–2000	Ye et al. (2011)	
	Qinghai–Tibet Plateau	Permafrost area	Decrease by <19% (20–50 years since 1996), decrease by 58% (2099)		+1°C in air temp. in 30 years since 1996	HADCM2	20–50 years since 1996	1996	Results of Li and Cheng (1999) after Cheng and Wu (2007)	
	Tibetan Plateau	Alpine vegetation	Most replaced by forest and shrubland		A1B	Pattern-scaled output of multiple models		2070–2099	1931–1960	Liang et al. (2012); Wang (2014)
Eastern China	Rice production	Yield would change on average by 7.5% to 17.5% (-10.4% to 3.0%), 0.0% to 25.0% (-26.7% to 2.1%), and -10.0% to 25.0% (-39.2% to -6.4%) during the 2020s, 2050s, and 2080s, respectively, in response to climate change, with (without) consideration of CO ₂ fertilization effects.		10 climate scenarios, relative to 1961–1990 levels						Tao and Zhang (2013)
Huang-Hai Plain in northeast China	Winter wheat yield	Increase by 0.2 Mg/ha (2015–45), increase by 0.8 Mg/ha (2070–2089)		A2, B2	HadCM3	2015–2045, 2070–2099	1961–1990	Thomson et al. (2006)		
Huang-Huai-Hai (3H) Plain	Wheat-maize relative yield change (R ² C)	+2°C & +5°C in temperature, +15 & –30% in precipitation, 500 & 700 ppmv CO ₂ ; decreased on average by -10.33% As above, with CO ₂ fertilization: $+4.46 \pm 14.83\%$ (2°C), $-5.78 \pm 25.82\%$ (5°C)				1966–2004	1966–2004	Liu, S. et al. (2010)		
South Korea	Paddy irrigation requirements	Decrease by 1–8%		A2, B2	HadCM3 (RCMs)	2010–2039, 2040–2069, 2070–2099	1961–1990	Chung et al. (2011)		
	Volumetric irrigation demand	Decrease by 4–10%								
Yongdam basin	Annual mean streamflow	Reduced by 7.6%	Future runoff may be higher during wet season and lower during dry season.		2×CO ₂	YONU GCM (WGEM)	2031–2050	1961–1980	Kim et al. (2007)	
China, Taiwan province	Upstream catchment of Shihmen reservoir	Runoff	Future runoff may be higher during wet season and lower during dry season.		A2, B2	CCSR CGCM2, CSIRO, ECHAM4, GFDL, HadCM3	2010–2039; 2040–2069; 2070–2099	1973–2000	Yu and Wang (2009)	
	Annual renewable water resource	Drop by 12.3%	Good (L1), good (L2), fair (L3), poor (L4), very poor (L5): No change in northern and eastern parts with L2; visibly deteriorate in southern part with L3 to L4; central part will be L4		A1B	JAM/MRI TL 959L60	2080–2099	1949–2000	Tsai and Huang (2012)	
	Water resource condition for five levels					JAM/MRI TL 959L60	2080–2099	1979–1998	Tsai and Huang (2011)	

Continued next page →

Table SM24-5 (continued)

SM24-8

Sub-region	Country or territory	Area	Parameters	Projected impacts	Scenario	GCM (RCM)	Period	Base year	Reference
North Asia	Russia, East of Ural	Siberia	Tundra area	Decrease by 93% as result of boreal forest expansion	+1% GHG per year	HADCM3 (GGA1)	2090–2100	1965–2000	Tchebakova et al. (2010)
		Steppe area	Steppe area	Increase by 27%					
		Tundra area	Steppe area	Decrease by 3% as result of boreal forest expansion	+1°C in annual mean global surface temp.	ECHAM4/OPYC3, HadCM3, AP RAS CM	Late 2030s to early 2050s	1961–1990	Golodzyatnikov and Denisenko (2007)
	Russia	Arctic	Ice-dependent mammals	Population declines in some species	Various	Various	21st century		Post et al. (2013); Kovacs et al. (2011)
		Pechora Sea	Coast recession rate	1.5- to 2.6-fold increase	+2°C in annual mean global surface temp. over 21st century		2100	c. 2000	Pavlidis et al. (2007)
		East of Urals	Frequency of food production shortfalls	+3 to 4 (A2) and +2 to 3 (B2) years/decade in 2070s	A2, B2	ECHAM, HadCM3	2070s	1961–1990	Alcamo et al. (2007)
South Asia	India	All	Forests	34 to 39% of forests to change forest type	A2, B2	HadRM3	2085	1961–1991	Chaturvedi et al. (2011)
		Indo-Gangetic Plains, Indore, Hyderabad, Dhanwad	Sorghum winter grain yield	Reduced by up to 7% by 2020, up to 11% by 2050, and up to 32% by 2080	A2a	HadCM3	2020, 2050, 2080	1970–1995	Srivastava et al. (2010)
		Pakistan	Swat & Chitral districts	Wheat yield	-7% & -24% (Swat district), +14% & 23% (Chitral district) September	1.5- & 3°C in temperature			
	Thailand	Chao Phraya River basin	River discharge	Decreased 60% in January, no significant change in September	A1B	MRI-AGCM + TRIP	2075–2099	1976–2000	Hussain and Mudasser (2007)
		Vietnam	Mekong River delta	Agricultural land	About 7% of Vietnam's agricultural land may be submerged by 1 m sea level rise	1 meter sea level rise scenario	no GCMs used		
		Iran	All	Deep aquifer recharge	Decreases by 50 to 100% in groundwater recharge in eastern region	A1B; B1; A2	CGCM 3.1	2010–2040, 2070–2100	Abbaspour et al. (2009)
West Asia	Jordan	Upper Jordan; Wadi Faynan	Stream flows, flood flow and numbers	Decrease by 12%	A2	(HadRM3)	2071–2100	1961–1990	Wade et al. (2010)
		Internal water resource	Internal water resource	Decreases from 464 to 419 and 412 km ³	A1B	HadCM3 (PRECIS)	2040–2069, 2070–2099	1961–1990	Chenoweth et al. (2011)
		Runoff	Runoff	-9.5% & -10% (Tigris–Euphrates River), -22% & -30% (Jordan River)					
	Eastern Mediterranean and Middle East region	Asian Russia, China, Mongolia, Kazakhstan	Permafrost area in Asia	Permafrost degradation	Spread from southern and low-altitude margins, advancing northwards and upwards	Multiple scenarios	Multiple GCMs	21st century	Multiple references, see section 24.4.2.3.
		Asian Russia, China	Siberia and Tibet	Permafrost distribution	Permafrost will remain only in Central and Eastern Siberia and in part of Tibet	A1B, A2	IAP RAS CM	Late 21st century	Elliseev et al. (2009)
		West, South, Southeast Asia	All countries with tropical coasts	Coral health	Large declines in structure and diversity	Several	Several	2050	Hoegh-Guldberg (2011); Burke et al. (2011)
Asia	Poverty			Negative impact on rice crop, increase in food prices and cost of living, increased poverty, projections for 2030 by GTAP Model under three scenarios resulting in low, medium and high productivity					Hertel et al. (2010)
	Tibet/Himalayas	Livelihoods		Loss of livelihoods of indigenous people from declining alpine biodiversity					Salick and Ross (2009); Xu et al. (2009)

Table SM24-6 | Summary of recent literature from East Asia (China and Japan) reporting phenological observations in relation to recent climate change. Studies differ in objectives, methods, locations, and study periods. The source publications should be consulted for details. Phenological responses are given in days per decade, unless otherwise indicated, with negative values indicating an earlier occurrence of the event (i.e., an advance), and positive values a later occurrence (i.e., a delay). The "major influence" column shows the environmental variable that the authors of the study considered most important.

Location	Latitude	Period	Type of data	Variable	Species	Response (timing)	Major influence	Source
China	All	1982–2006	Observations and NDVI	Spring green-up		$-2.9 \pm 2.3 \text{ days dec}^{-1}$	Temperature	Ma and Zhou (2012)
	Most	1952–2007	Observations	First leaf date	20 spp. broadleaved deciduous	$-1.1 \text{ days dec}^{-1}$	Temperature	Ge et al. (2013a)
		1960–2009	Observations	First leaf date	4 tree spp.	$-1.1 \text{ days dec}^{-1}$	Temperature	Dai et al. (2013a)
				Leaf coloring date	4 tree spp.	$+0.9 \text{ days dec}^{-1}$		
	>35°N and <35°N	1951–2007	Meteorological data	Thermal growing season length		<ul style="list-style-type: none"> • N: $+2.3 \text{ days dec}^{-1}$ • S: $+1.3 \text{ days dec}^{-1}$ 	Temperature	Song et al. (2010)
				Start of thermal growing season		<ul style="list-style-type: none"> • N: $-1.7 \text{ days dec}^{-1}$ • S: $-0.6 \text{ days dec}^{-1}$ 		
Eastern China	18–54°N	1982–2006	GIMMS-NDVI	Spring green-up	All	Advance in most areas except northeast China plain	Temperature	Yu et al. (2013a)
Xishuangbanna, China	21°N	1973–1999	Observations	Leaf budburst	21 species	$+14 \text{ days (7 spp.)}$	Temperature	Zhao et al. (2013)
				Growing season length	21 species	$+35 \text{ days (4 spp.)}$		
				First flowering	21 species	Varied	Temperature, rainfall	
China	23–46°N	1952–2007	Observations	First leafing	<i>Fraxinus chinensis</i>	<ul style="list-style-type: none"> • NE: $-1.5 \text{ days dec}^{-1}$ • N: $-2.0 \text{ days dec}^{-1}$ • NW: $-1.4 \text{ days dec}^{-1}$ • E: $-0.9 \text{ days dec}^{-1}$ • C: $-1.1 \text{ days dec}^{-1}$ • S: $-0.3 \text{ days dec}^{-1}$ • SW: $-0.6 \text{ days dec}^{-1}$ 	Temperature	Wang et al. (2012)
Yangtze River delta, China	28–32°N	1834–2010	Observations	Flowering	14 ornamental species	Delayed 1843–1893, advanced 1893–1905, 1990–2010.	Temperature	Zheng et al. (2013)
Temperate China	28–54°N	1982–2006	GIMMS-NDVI	Spring green-up	All biomes	Advanced to mid-late 1990s, then delayed to 2006	Temperature	Wu and Liu (2013)
Temperate China (incl. Tibet)	c. 28–54°N	1982–1998	GIMMS NDVI	Start of growing season	All	$-6.8 \text{ days dec}^{-1}$ 1982–1998, $+21.3 \text{ days dec}^{-1}$ 1998–2005	Temperature, snow depth	Yu et al. (2013b)
China	>30°N	1986–2005	Observations	Leaf unfolding	<i>Ulmus pumila</i>	$-4.0 \text{ days dec}^{-1}$	Temperature	Chen and Xu (2012)
				Leaf fall	<i>Ulmus pumila</i>	$+2.2 \text{ days dec}^{-1}$		
		1982–2010	GIMMS-NDVI3g	Spring green-up	All	$-1.3 \pm 0.6 \text{ days dec}^{-1}$	Temperature	Cong et al. (2013)
North China	33–53°N	1960–2009	Observations and modeling	First leaf unfolding	4 deciduous tree spp.	$-1.4 \text{ to } -1.6 \text{ days dec}^{-1}$	Temperature	Xu and Chen (2013)
Xi'an, China	34°N	1963–1996 vs. 2003–2011	Observations	First leafing	42 woody species	$-5.5 \text{ days between periods}$	Temperature	Dai et al. (2013b)
				Leaf coloring	42 woody species	$+16.1 \text{ days between periods}$		
				First flowering	42 woody species	$-10.2 \text{ days between periods}$		
Beijing and Xi'an	34–40°N	1963–2010	Observations	Leaf coloring	<i>Acer mono</i>	$+4 \text{ to } 5 \text{ days dec}^{-1}$	Temperature	Ge et al. (2013b)
Temperate China	34–47°N	1963–2009	Observations	First flowering	210 species	<ul style="list-style-type: none"> • NE: $-1.5 \text{ days dec}^{-1}$ • N: $-2.2 \text{ days dec}^{-1}$ 	Temperature	Dai et al. (2013c)
Inner Mongolia, China	37–53°N	1982–2006	Observations	First flowers	<i>Populus tomentosa</i>	$-2.9 (-6.5 \text{ to } +1.5) \text{ days dec}^{-1}$	Temperature	Wu et al. (2009)
				Leaf fall	<i>Populus tomentosa</i>	$+3.1 (-5.8 \text{ to } +9.5) \text{ days dec}^{-1}$		
Beijing, China	40°N	1963–2008	Observations	Growing season length	<i>Castanea mollissima</i>	$+4.3 \text{ days dec}^{-1}$	Temperature	Guo et al. (2013)
				Leaf coloring	<i>Castanea mollissima</i>	Not significant		
				First flowers	<i>Castanea mollissima</i>	$-1.6 \text{ days dec}^{-1}$		
	1963–1989, 1990–2007	Observations	First flowers	48 woody species		$-5.4 \text{ days between periods}$	Temperature	Bai et al. (2011)

Continued next page →

Table SM24-6 (continued)

Location	Latitude	Period	Type of data	Variable	Species	Response (timing)	Major influence	Source
Northeast China	40–52°N	1980–2005	Observations	Leafing	11 woody species	−2.3 days dec ^{−1}	Temperature	Li and Zhou (2010)
				Leaf yellowing	11 woody species	+1.9 days dec ^{−1}		
Inner Mongolia, China	42°N	2006–2009	Experimental warming (day and night)	Flowering and fruiting	8 species in temperate steppe	−0.8 days (flowering), −0.7 days (fruiting) with night warming	Temperature	Xia and Wan (2013)
Northeast China	45–53°N	2001–2009	MODIS EVI	Start of season	Broadleaved deciduous forest	Advance	Temperature	Cai et al. (2012)
Tibet, China	1961–2000	Herbarium collections	Flowering	41 species	−5.0 days dec ^{−1}	Temperature	Li et al. (2013)	
		GIMMS-NDVI	Spring green-up	All	Advance to 1999, then delay	Temperature	Piao et al. (2011)	
		GIMMS-NDVI	Spring green-up	Grassland	Advance to 1990s, then delay	Temperature	Yu et al. (2012)	
			Senescence and end of growing season	Grassland	Mostly earlier			
	1999–2009	SPOT-VGT NDVI	Start of growth season	Grassland	−6 days dec ^{−1}		Ding et al. (2013)	
			End of growing season	Grassland	+2 days dec ^{−1}			
	1982–2011	GIMMS and SPOT-VGT NDVI	Spring green-up		−10.4 days dec ^{−1}	Temperature	Zhang et al. (2013a)	
	1982–2006	GIMMS-NDVI	Spring green-up	All	Earlier in most areas	Temperature	Panday and Ghimire (2012)	
	1994–2005	Observations	Growing season	<i>Festuca rubra</i> , <i>Kobresia pygmaea</i> , <i>Poa pratensis</i>	Longer	Precipitation	Zhang et al. (2013b)	
Japan	31–44°N	1969–1989, 1990–2005	Observations	First flowers	<i>Prunus mume</i>	−7.0 (−22.8 to +8.0) days between periods	Temperature	Doi (2007)
		1953–2005	Observations	Leaf budburst	<i>Morus bombycis</i>	−1.3 days dec ^{−1}	Temperature	Doi (2012)
	33–38°N	1953–2005		Leaf fall	<i>Morus bombycis</i>	+2.4 days dec ^{−1}		
			Observations	Leaf budburst	<i>Ginkgo biloba</i> , <i>Morus bombycis</i> , <i>Salix babylonica</i> , <i>Camellia sinensis</i>	−2.7 days dec ^{−1}	Temperature	Doi and Katano (2008)
Kyoto, Japan	35°N	812–2005	Observations	Peak flowering	<i>Prunus jamaikura</i>	General advance after 1820s	Temperature	Aono and Kazui (2008)
Japan	36–41°N	1977–2004	Observations	Budburst	<i>Malus pumila</i> var. <i>domestica</i>	−1.8 to −3.6 days dec ^{−1}	Temperature	Fujisawa and Kobayashi (2010)
				Flowering	<i>Malus pumila</i> var. <i>domestica</i>	−2.1 to −3.5 days dec ^{−1}		
	42°N	3 years	Experimental soil warming	Leaf phenology	7 understory species	Variable between species	Temperature	Ishioka et al. (2013)

Table SM24-7 | Examples of adaptation options for agriculture in Asia.

Crop	Country/region	Potential adaptation strategies	Benefits/co-benefits	References
Wheat	General	Conservation agriculture (reductions in tillage, surface retention of adequate crop residues, and diversified, economically viable crop rotations)	Improve rural incomes and livelihoods by reducing production costs, managing agroecosystem productivity and diversity more sustainably, and minimizing unfavorable environmental impacts	Ortiz et al. (2008)
	Pakistan	Development of short duration and high yield varieties of wheat	Can withstand climatic anomalies expected in future	Hussain and Mudasser (2007)
	Indo-Gangetic Plains, India	Development of heat-tolerant wheat germplasm, as well as cultivars	Better adapted to heat and conservation agriculture	Ortiz et al. (2008)
Barley; wheat	Jordan	Soil water conservation. Selection of drought tolerant genotypes with shorter growing seasons	Increase available water to crop	Al-Bakri et al. (2010)
Sorghum	India	Changing variety and sowing date	Reduce impacts on monsoon sorghum to about 10%, 2% and 3% in 2020 scenario. Reduce impacts on winter crop to 1–2% in 2020, 3–8% in 2050 and 4–9% in 2080.	Srivastava et al. (2010)
Rice	Sri Lanka	Traditional approaches for resolving water stress, such as increasing water use efficiency, water harvesting and/or reducing cropped areas. Earlier planting and shorter duration varieties to avoid impacts of less rainfall in January and February		De Silva et al. (2007)
	China	Shifts in planting dates and automatic application of irrigation and fertilization. Selection for more temperature-tolerant cultivars and later-maturing cultivars to take advantage of longer growing seasons		Tao et al. (2008)
Corn	China	Using high-temperature sensitive varieties. Early planting, fixing variety growing duration, and late planting	Using high-temperature sensitive varieties, maize yield could increase on average by 1.0–6.0%, 9.9–15.2%, and 4.1–5.6% by adopting adaptation options of early planting, fixing variety growing duration, and late planting, respectively	Tao and Zhang (2010)
General	India	Water harvesting		Kelkar et al. (2008)
	South Asia	Increasing livestock production relative to crops. Selection of crop varieties. Livelihood diversification		Morton (2007)
	Central Asia	Replacement of existing network of open irrigation canals by more efficient drip irrigation systems Development of early warning systems, such as drought forecast, pest and epidemic disease forecasts, and water quality monitoring systems	Could significantly reduce evaporative water loss, while simultaneously improving crop productivity, reducing soil salinization, and decreasing risks of water contamination and transmission of vector-borne and waterborne diseases	Lioubimtseva and Henebry (2009)
	Central and West Asia	Changing of cropping systems and patterns, switching from cereal-based systems to cereal-legumes and diversifying production systems into higher value and greater water use efficient options. Using supplementary irrigation systems, more efficient irrigation practices and adaptation and adoption of existing and new water harvesting technologies. Development of more drought and heat tolerant germplasm using traditional and participatory plant breeding methodologies and better predictions of extreme climatic events		Thomas (2008)
	Russia	Crop substitution, diversification of crops, expanding irrigated agricultural areas, strategic food reserves, improving management, monitoring and early warning systems, food imports from abroad		Alcamo et al. (2007)
	Philippines	Crop diversification; change of crop varieties, use of water conservation practices		Peras et al. (2008); Lasco et al. (2011)
	General	Cultivars with multiple resistance to insects and diseases		Sharma et al. (2010)

Table SM24-8 | Examples of adaptation options for securing livelihoods in Asia.

Aspect/issues	Country/region	Potential adaptation strategies	Benefits/co-benefits	References
Delay and shortfall in rainfall	Indonesia	Access to credit and public works project	Able to protect food expenditure in the face of weather shocks	Skoufias et al. (2011)
General (droughts, floods etc.)	General	Weather index insurance, cattle insurance, seed banks, credit facilities, assisted migration, cash for work	Poverty-centered adaptation, creation of assets and access to resources	Barrett et al. (2007); Tanner and Mitchel (2008); Jarvis et al. (2011)
		Assisted migration	Build financial, social, and human capital	Barnett and Webber (2010)
	Vietnam	Yield growth and improving agriculture labor productivity	Rural poverty reduction, livelihood diversification	Janvry and Sadoulet (2010)
Droughts and floods	Philippines	Bundling of improved varieties and agronomic practices and combination of production and market support	Economic benefits and social learning	Acosta-Michlik and Espaldon (2008)
General	Asia	Community based adaptation	Capture information at the grassroots, help integrating disaster risk reduction, development, and climate change adaptation, connect local communities and outsiders, and address the location-specific nature of adaptation	van Aalst et al. (2008); Heltberg et al. (2010); Rosegrant (2011)
		Forest management	Resilient livelihoods, buffer from shocks	Chhatre and Agrawal (2009)
		Securing rights to resources, community forest tenure rights	Resilient livelihood benefits to the poor indigenous and traditional people	Macchi et al. (2008); Angelsen (2009)
Biodiversity loss	Tibet	Greater involvement of traditional and indigenous people in climate change adaptation decision making	Indigenous knowledge from the years of living in close harmony with nature	Byg and Salick (2009); Salick and Ross (2009)

Table SM24-9 | Recent publications on changes in Central Asian glaciers.

Region	Period	Initial area (km ²)	Area change, km ² (%)	References
Akshiiarak (Inner Tien Shan)	1977–2001	406.8	-93.6 (-23)	Khromova et al. (2003)
	1977–2003	406.8	-35.15 (-8.6)	Aizen et al. (2006)
Zailiyskiy Alatau (Northern Tien Shan)	1955–1990	287.3	-81.8 (-29)	Vilesov and Uvarov (2001)
Sokoluk river basin, Kirgizkiy range (Northern Tien Shan)	1963–1986	31.7	-4.2 (-13.3)	Niederer et al. (2008)
	1986–2000	27.5	-4.7 (-17.1)	
Glacier No. 1, Urumqi (Eastern Tien Shan)	1962–2003	1.94	-0.24 (-12.4)	Ye et al. (2005)
Terskey-Alatoo (Issyk-Kul Lake Basin, Northern Tien Shan)	1971–2002	245	-18 (-8)	Narama et al. (2006)
Akesu river basin (Tarim river Basin, Central Tien Shan)	1963–1999	1760	-58.6 (-3.3)	Liu et al. (2006)
Kaidu river basin (Tarim river Basin, Central Tien Shan)	1963–2000	333	-38.5 (-11.6)	
Southern Tien Shan, Chinese territory	1960s–1999	2093.8	-96.3 (-4.6)	Ding et al. (2006)
Tien Shan (all mountain systems)	1970s–2008	13,271	-1,128 (8.5%)	Aizen (2011)
Altai–Sayán (all mountain systems)	1950–2000	42,565	-5959 (14%)	

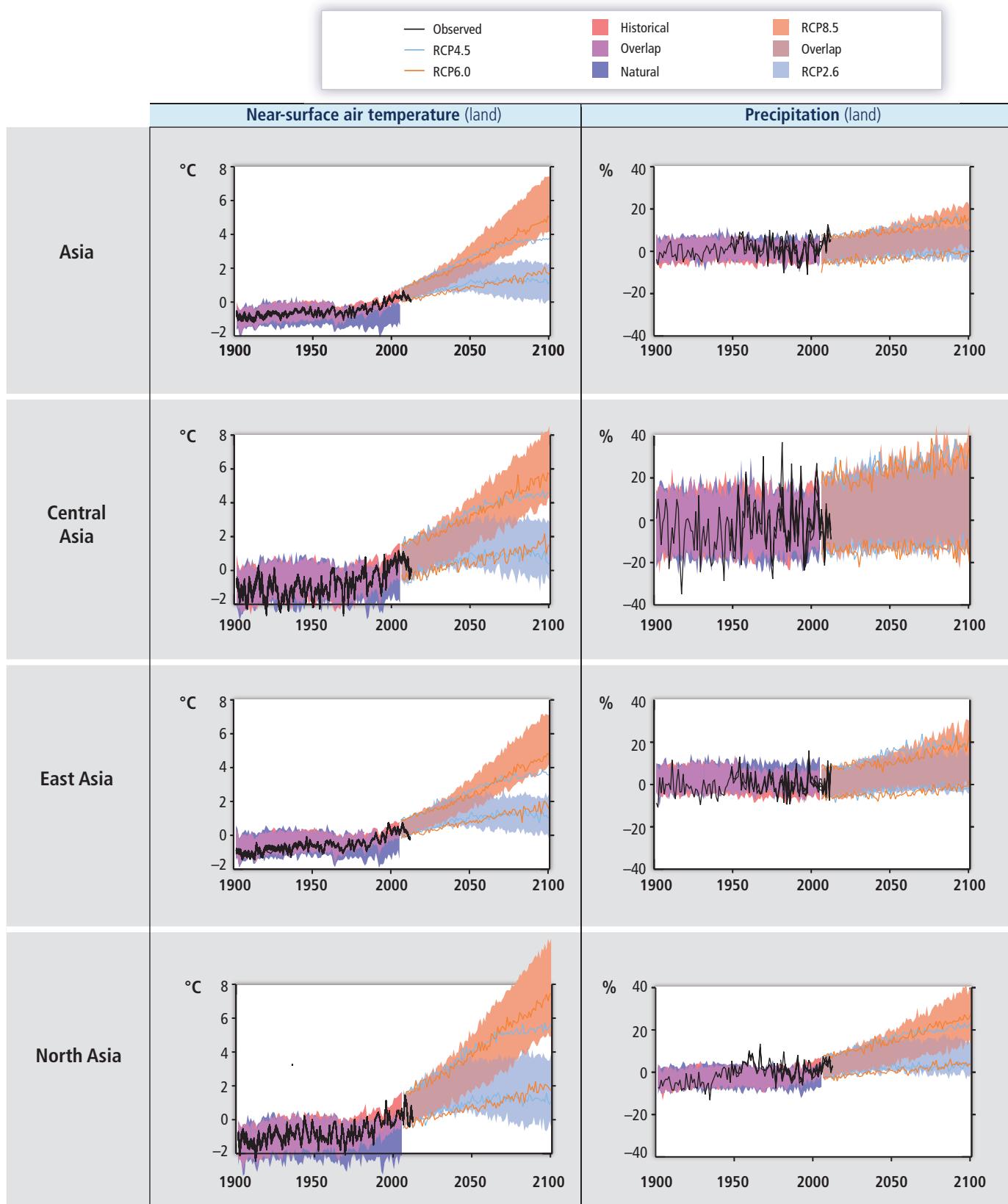


Figure SM24-1 | Observed and simulated variations in past and projected future annual average temperature (left) and precipitation (right) over land areas of the regions shown in Figure 24-1. Black lines show various estimates from observational measurements. Shading denotes the 5–95 percentile range of climate model simulations driven with "historical" changes in anthropogenic and natural drivers (63 simulations), historical changes in "natural" drivers only (34), the "RCP2.6", "RCP4.5", and "RCP8.5" emissions scenarios (63 each), and the "RCP6.0" scenario (45). Data are anomalies from the 1986–2005 average of the individual observational data (for the observational time series) or of the corresponding historical all-forcing simulations. Further details are given in Table SM21-5.

Continued next page →

Figure SM24-1 (continued)

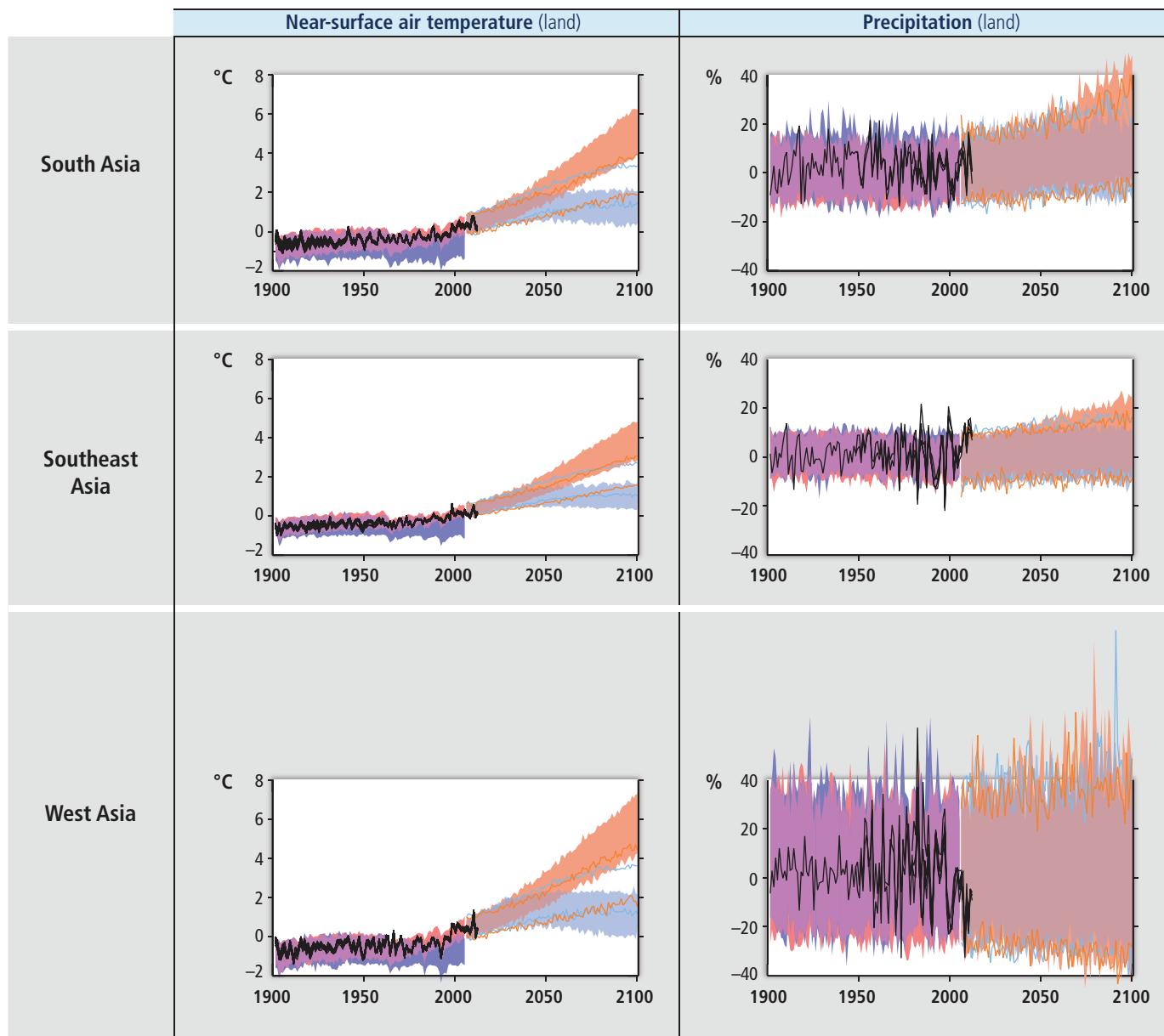




Figure SM24-2 | Geographical boundary and major cities of the Lower Mekong Basin (MRC, 2009).

References

- Abbaspour, K.C., M. Faramarzi, S.S. Ghasemi, and H. Yang, 2009: Assessing the impact of climate change on water resources in Iran. *Water Resources Research*, **45** (10), W10434.
- Acosta-Michlik, L. and V. Espaldon, 2008: Assessing vulnerability of selected farming communities in the Philippines based on a behavioural model of agent's adaptation to global environmental change. *Global Environmental Change*, **18** (4), 554-563.
- Aizen, V.B., V.A. Kuzmichenok, A.B. Surazakov, and E.M. Aizen, 2006: Glacier changes in the central and northern Tien Shan during the last 140 years based on surface and remote-sensing data. *Annals of Glaciology*, **43**, 202-213.
- Aizen, V.B., E.M. Aizen, and V.A. Kuzmichonok, 2007: Glaciers and hydrological changes in the Tien Shan: simulation and prediction. *Environmental Research Letters*, **2** (4), 10.
- Aizen, V.B., 2011: Altai Glaciers. Pamir Glaciers. Tien Shan Glaciers. In: *Encyclopedia of Snow, Ice and Glaciers* [Singh, V.P., P. Singh, and U.K. Haritashya (eds.)]. Springer pp. 38-39; 1179-1181.
- Al-Bakri, J., A. Suleiman, F. Abdulla, and J. Ayad, 2010: Potential impact of climate change on rainfed agriculture of a semi-arid basin in Jordan. *Physics and Chemistry of the Earth, Parts A/B/C*, **36** (5-6), 125-134.
- Alcamo, J., N. Dronin, M. Endejan, G. Golubev, and A. Kirilenko, 2007: A new assessment of climate change impacts on food production shortfalls and water availability in Russia. *Global Environmental Change*, **17** (3-4), 429-444.
- Aldrian, E. and Y.S. Djamil, 2008: Spatio-temporal climatic change of rainfall in East Java Indonesia. *International Journal of Climatology*, **28** (4), 435-448.
- Allison, I., 2011: Papua. In: *Encyclopedia of Snow, Ice and Glaciers* [Singh, V.P., P. Singh, and U.K. Haritashya (eds.)]. Springer, Dordrecht, Netherlands, pp. 815-817.
- Ananicheva, M.D., M.M. Koreyshe, and S. Takahashi, 2005: Assessment of glacier shrinkage from the maximum in the Little Ice Age in the Suntar-Khayata Range, North-East Siberia. *Bulletin of Glaciological Research*, **22**, 9-17.
- Ananicheva, M.D., G.A. Kapustin, and M.M. Koreyshe, 2006: Glacier changes in Suntar-Khayata mountains and Chersky Range from the Glacier Inventory of the USSR and satellite images 2001–2003. *Data of glaciologic studies*, Moscow, 163-169.
- Angelsen, A., 2009: *Realizing REDD+: National strategy and policy options*. CIFOR, 362 pp. www.oecd.org/env/c45153979.pdf.
- Anisimov, O.A., Y.A. Anokhin, L.I. Boltneva, E.A. Vaganov, G.V. Gruza, A.S. Zaitsev, A.N. Zolotokrylin, Y.A. Izrael, G.E. Insarov, I.L. Karol, V.M. Kattsov, N.V. Kobysheva, A.G. Kostianoy, A.N. Krenke, A.V. Mescherskaya, V.M. Mirvis, V.V. Oganesyan, A.V. Pchelkin, B.A. Revich, A.I. Reshetnikov, V.A. Semenov, O.D. Sirotenko, P.V. Sporyshev, F.S. Terziev, I.E. Frolov, V.C. Khon, A.V. Tsyban, B.G. Sherstyukov, I.A. Shiklomanov, and V.V. Yasukevich, 2008a: *Assessment Report on Climate Change and its Consequences in Russian Federation - General Summary*. Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), Moscow, Russia, 25 pp.
- Anisimov, O.A., Y.A. Anokhin, A.N. Krenke, M.D. Ananicheva, P.M. Lurie, and L.T. Myach, 2008b: Continental Permafrost and Glaciers. In: *Assessment Report on Climate Change and its Consequences in Russian Federation. Volume II Climate Change Consequences*. Planeta Publishing, Moscow, pp. 124-134.
- Aono, Y. and K. Kazui, 2008: Phenological data series of cherry tree flowering in Kyoto, Japan, and its application to reconstruction of springtime temperatures since the 9th century. *International Journal of Climatology*, **28** (7), 905-914.
- Archer, D.R., N. Forsythe, H.J. Fowler, and S.M. Shah, 2010: Sustainability of water resources management in the Indus Basin under changing climatic and socio economic conditions. *Hydrology and Earth System Sciences*, **14** (8), 1669-1680.
- Attri, S.D. and A. Tyagi, 2010: *Climate Profile of India*. India Meteorological Department, Ministry of Earth Sciences, New Delhi, India, 122 pp.
- Bai, J., X. Chen, L. Yang, H. Fang, 2012: in, Y. Xu, J. Ji, G. Wen, and J. Richey, 2010: Monitoring variations of inland lakes in the arid region of Central Asia. *Frontiers in Earth Science*, **6**(2), 147-156.
- Bai, J., Q. Ge, and J. Dai, 2011: The response of first flowering dates to abrupt climate change in Beijing. *Advances in Atmospheric Sciences*, **28** (3), 564-572.
- Barnett, J.R. and M. Webber, 2010: *Accommodating migration to promote adaptation to climate change*. World Bank Policy Research Working Paper, 62 pp. www.ccdcommission.org/Filer/documents/Accommodating%20Migration.pdf.

- Barrett, C.B., B.J. Barnett, M.R. Carter, S. Chantarat, J.W. Hansen, A.G. Mude, D.E. Osgood, J.R. Skees, C.G. Turvey, and M.N. Ward, 2007:** *Poverty traps and climate and weather risk: Limitations and opportunities of index-based risk financing* IRI Technical Report 07-03, 57 pp., preventionweb.net/go/8079.
- Black, R., W.N. Adger, N.W. Arnell, S. Dercon, A. Geddes, and D. Thomas, 2011:** The effect of environmental change on human migration. *Global Environmental Change*, **21**, Supplement 1 (0), S3-S11.
- Blok, D., U. Sassi-Klaassen, G. Schaeppman-Strub, M.M.P.D. Heijmans, P. Sauren, and F. Berendse, 2011:** What are the main climate drivers for shrub growth in Northeastern Siberian tundra? *Biogeosciences*, **8** (5), 1169-1179.
- Bolch, T., 2007:** Climate change and glacier retreat in northern Tien Shan (Kazakhstan/Kyrgyzstan) using remote sensing data. *Global and Planetary Change*, **56** (1-2), 1-12.
- Brutsaert, W. and M. Sugita, 2008:** Is Mongolia's groundwater increasing or decreasing? The case of the Kherlen River basin. *Hydrological Sciences Journal-Journal Des Sciences Hydrologiques*, **53** (6), 1221-1229.
- Burke, L., K. Reydar, M. Spalding, and A. Perry, 2011:** *Reefs at Risk Revisited*. Washington, DC: World Resources Institute.
- Byg, A. and J. Salick, 2009:** Local perspectives on a global phenomenon—climate change in Eastern Tibetan villages. *Global Environmental Change*, **19**(2), 156-166.
- Cai, H., S. Zhang, and X. Yang, 2012:** Forest dynamics and their phenological response to climate warming in the Khingan Mountains, Northeastern China. *International Journal of Environmental Research and Public Health*, **9**(11), 3943-3953.
- Champathong, A., D. Komori, M. Kiguchi, T. Sukhapunnaphan, T. Oki, and T. Nakagawa, 2013:** Future projection of mean river discharge climatology for the Chao Phraya River basin. *Hydrological Research Letters*, **7** (2), 36-41.
- Chaturvedi, R.K., R. Gopalakrishnan, M. Jayaraman, G. Bala, N.V. Joshi, R. Sukumar, and N.H. Ravindranath, 2011:** Impact of climate change on Indian forests: a dynamic vegetation modeling approach. *Mitigation and Adaptation Strategies for Global Change*, **16** (2), 119-142.
- Chaudhry, Q.-u.-Z., A. Mahmood, G. Rasul, and M. Afzaal, 2009:** *Climate Change Indicators of Pakistan*. Pakistan Meteorological Department, Islamabad, Pakistan, 43 pp.
- Chen, I.C., J.K. Hill, H.J. Shiu, J.D. Holloway, S. Benedick, V.K. Chey, H.S. Barlow, and C.D. Thomas, 2011:** Asymmetric boundary shifts of tropical montane Lepidoptera over four decades of climate warming. *Global Ecology and Biogeography*, **20** (1), 34-45.
- Chen, X. and L. Xu, 2012:** Phenological responses of *Ulmus pumila* (Siberian Elm) to climate change in the temperate zone of China. *International journal of biometeorology*, **56** (4), 695-706.
- Chen, Y.-n., W.-h. Li, C.-c. Xu, and X.-m. Hao, 2007:** Effects of climate change on water resources in Tarim River Basin, Northwest China. *Journal of Environmental Sciences*, **19** (4), 488-493.
- Chen, Y., C. Xu, X. Hao, W. Li, Y. Chen, C. Zhu, and Z. Ye, 2009:** Fifty-year climate change and its effect on annual runoff in the Tarim River Basin, China. *Quaternary International*, **208**, 53-61.
- Chen, Z., Y. Chen, and B. Li, 2013:** Quantifying the effects of climate variability and human activities on runoff on Kaidu River Basin in arid region of northwest China. *Theoretical and Applied Climatology*, **111** (3-4), 537-545.
- Cheng, G.D. and T.H. Wu, 2007:** Responses of permafrost to climate change and their environmental significance, Qinghai-Tibet Plateau. *Journal of Geophysical Research-Earth Surface*, **112** (F2), F02S03.
- Chenoweth, J., P. Hadjinicolaou, A. Bruggeman, J. Lelieveld, Z. Levin, M.A. Lange, E. Koplaki, and M. Hadjikakou, 2011:** Impact of climate change on the water resources of the eastern Mediterranean and Middle East region: Modeled 21st century changes and implications. *Water Resources Research*, **47** (6), W06506.
- Chhatre, A. and A. Agrawal, 2009:** Trade-offs and synergies between carbon storage and livelihood benefits from forest communities. *The National Academy of Sciences of the United States of America*, **106**, 17667-17670.
- Chung, S.O., J.A. Rodriguez-Diaz, E.K. Weatherhead, and J.W. Knox, 2011:** Climate Change Impacts on Water for Irrigating Paddy Rice in South Korea. *Irrigation and Drainage*, **60** (2), 263-273.
- Coles, S.L. and B.M. Riegl, 2013:** Thermal tolerances of reef corals in the Gulf: A review of the potential for increasing coral survival and adaptation to climate change through assisted translocation. *Marine Pollution Bulletin*, **72** (2), 323-332.
- Cong, N., T. Wang, H. Nan, Y. Ma, X. Wang, R.B. Myneni, and S. Piao, 2013:** Changes in satellite-derived spring vegetation green-up date and its linkage to climate in China from 1982 to 2010: a multimethod analysis. *Global Change Biology*, **19** (3), 881-891.
- Cook, E., P. Krusic, K. Anchukaitis, B. Buckley, T. Nakatsuka, M. Sano, and PAGES Asia2k Members, 2013:** Tree-ring reconstructed summer temperature anomalies for temperate East Asia since 800 C.E. *Climate Dynamics*, **10.1007/s00382-012-1611-x**.
- Dagvadorj, D., L. Natsagdorj, J. Dorjpurev, and B. Namkhainyam, 2009:** *Mongolia Assessment Report on Climate Change 2009*. Ministry of Environment, Nature and Tourism, Ulaanbaatar, Mongolia, 228 pp.
- Dai, J., W. H., and Q. Ge, 2013a:** The spatial pattern of leaf phenology and its response to climate change in China. *International journal of biometeorology*, **10.1007/s00484-013-0679-2**.
- Dai, J., H. Wang, and Q. Ge, 2013b:** Multiple phenological responses to climate change among 42 plant species in Xi'an, China. *International journal of biometeorology*, **57** (5), 749-758.
- Dai, J., H. Wang, and Q. Ge, 2013c:** The decreasing spring frost risks during the flowering period for woody plants in temperate area of eastern China over past 50 years. *Journal of Geographical Sciences*, **23** (4), 641-652.
- Dasgupta, S., B. Laplante, C. Meisner, D. Wheeler, and J. Yan, 2009:** The impact of sea level rise on developing countries: a comparative analysis. *Climatic Change*, **93** (3-4), 379-388.
- De Costa, W.A.J.M., 2008:** Climate change in Sri Lanka: myth or reality? Evidence from long-term meteorological data. *Journal of the National Science Foundation of Sri Lanka*, **36**, 63-88.
- De Jong, R., J. Verbesselt, M.E. Schaepman, and S. de Bruin, 2012:** Trend changes in global greening and browning: contribution of short-term trends to longer-term change. *Global Change Biology*, **18** (2), 642-655.
- De Silva, C.S., E.K. Weatherhead, J.W. Knox, and J.A. Rodriguez-Diaz, 2007:** Predicting the impacts of climate change—A case study of paddy irrigation water requirements in Sri Lanka. *Agricultural Water Management*, **93** (1-2), 19-29.
- Ding, M., Y. Zhang, X. Sun, L. Liu, Z. Wang, and W. Bai, 2013:** Spatiotemporal variation in alpine grassland phenology in the Qinghai-Tibetan Plateau from 1999 to 2009. *Chinese Science Bulletin*, **58** (3), 396-405.
- Ding, Y.J., S.Y. Liu, J. Li, and D.H. Shangguan, 2006:** The retreat of glaciers in response to recent climate warming in western China. *Annals of Glaciology*, **43**, 97-105.
- Doi, H., 2007:** Winter flowering phenology of Japanese apricot *Prunus mume* reflects climate change across Japan. *Climate Research*, **34** (2), 99-104.
- Doi, H. and I. Katano, 2008:** Phenological timings of leaf budburst with climate change in Japan. *Agricultural and Forest Meteorology*, **148** (3), 512-516.
- Doi, H., 2012:** Response of the *Morus bombycis* growing season to temperature and its latitudinal pattern in Japan. *Int'l Journal of Biometeorology*, **56** (5), 895-902.
- Dulamsuren, C., M. Hauck, and C. Leuschner, 2010a:** Recent drought stress leads to growth reductions in *Larix sibirica* in the western Khentey, Mongolia. *Global Change Biology*, **16** (11), 3024-3035.
- Dulamsuren, C., M. Hauck, M. Khishigjargal, H.H. Leuschner, and C. Leuschner, 2010b:** Diverging climate trends in Mongolian taiga forests influence growth and regeneration of *Larix sibirica*. *Oecologia*, **163** (4), 1091-1102.
- Eliseev, A.V., M.M. Arzhanov, P.F. Demchenko, and Mokhov, II, 2009:** Changes in climatic characteristics of Northern Hemisphere extratropical land in the 21st century: Assessments with the IAP RAS climate model. *Izvestiya Atmospheric and Oceanic Physics*, **45** (3), 271-283.
- Fujisawa, M. and K. Kobayashi, 2010:** Apple (*Malus pumila* var. *domestica*) phenology is advancing due to rising air temperature in northern Japan. *Global Change Biology*, **16** (10), 2651-2660.
- Gabrielyan, A., D. Harutyunyan, N. Aslanyan, and R. Stepanyan, 2010:** *Second National Communication: Under the United Nations Framework Convention on Climate Change*. Ministry of Nature Protection, Yerevan, Armenia, 132 pp.
- Ganguly, N.D., 2011:** Investigating the causes of climate change in India with satellite measurements. *International Journal of Remote Sensing*, **32**(3), 687-700.
- Ge, Q., H. Wang, and J. Dai, 2013a:** Simulating changes in the leaf unfolding time of 20 plant species in China over the twenty-first century. *International journal of biometeorology*, **10.1007/s00484-013-0671-x**.
- Ge, Q., J. Dai, J. Liu, S. Zhong, and H. Liu, 2013b:** The effect of climate change on the fall foliage vacation in China. *Tourism Management*, **38**, 80-84.
- Ginn, W.L., T.C. Lee, and K.Y. Chan, 2009:** Past and future changes in the climate of Hong Kong. *Acta Meteorologica Sinica*, **24** (2), 163-175.
- Golubyatnikov, L.L. and E.A. Denisenko, 2007:** Model estimates of climate change impact on habitats of zonal vegetation for the plain territories of Russia. *Biology Bulletin*, **34** (2), 170-184.

- Guest**, J.R., A.H. Baird, J.A. Maynard, E. Muttaqin, A.J. Edwards, S.J. Campbell, K. Yewdall, Y.A. Affendi, and L.M. Chou, 2012: Contrasting patterns of coral bleaching susceptibility in 2010 suggest an adaptive response to thermal stress. *PLoS ONE*, **7** (3), e33353.
- Guo**, L., J. Dai, S. Ranjikar, J. Xu, and E. Luedeling, 2013: Response of chestnut phenology in China to climate variation and change. *Agricultural and Forest Meteorology*, **180** (0), 164-172.
- Hao**, X., Y. Chen, C. Xu, and W. Li, 2008: Impacts of climate change and human activities on the surface runoff in the Tarim River basin over the last fifty years. *Water resources management*, **22** (9), 1159-1171.
- Heltberg**, R., R. Prabhu, and H. Gitay, 2010: *Community-based adaptation: Lessons from the development marketplace 2009 on adaptation to climate change*. FEEM Working Paper No 84, 59 pp.
- Hertel**, T.W., M.B. Burke, and D.B. Lobell, 2010: The poverty implications of climate-induced crop yield changes by 2030. *Global Environmental Change*, **20** (4), 577-585.
- Hoegh-Guldberg**, O., 2011: Coral reef ecosystems and anthropogenic climate change. *Regional Environmental Change*, **11** (Suppl 1) (Climate hotspots: key vulnerable regions, climate change and limits to warming), S215-S227.
- Hsu**, H.-H., C.-T. Chen, M.-M. Lu, Y.-M. Chen, C. Chou, and Y.-C. Wu, 2011: *2011 Taiwan Scientific Report on Climate Change*. Policy and Law Center for Environmental Sustainability, National Taiwan University, Taipei, Taiwan, 362 pp.
- Hussain**, S.S. and M. Mudasser, 2007: Prospects for wheat production under changing climate in mountain areas of Pakistan – An econometric analysis. *Agricultural Systems*, **94** (2), 494-501.
- Iliasov**, S.A., O.A. Podrezov, and E.M. Rodina, 2003: *First National Communication of the Kyrgyz Republic under the UN Framework Convention on Climate Change*. Ministry of Ecology and Emergencies, Bishkek, Kyrgyzstan, 98 pp.
- Iqbal**, M.C.M., 2010: *Vulnerability and Adaptation Assessment*. Climate Change Division of the Ministry of Environment and Natural Resources, Sri Lanka, 265 pp.
- Ishioka**, R., O. Muller, T. Hiura, and G. Kudo, 2013: Responses of leafing phenology and photosynthesis to soil warming in forest-floor plants. *Acta Oecologica-International Journal of Ecology*, **51**, 34-41.
- Janvry**, A. and E. Sadoulet, 2010: Agricultural growth and poverty reduction: Additional evidence. *The World Bank Research Observer*, **25** (1), 1-20.
- Jarvis**, A., C. Lau, S. Cook, E. Wollenberg, J. Hansen, O. Bonilla, and A. Challinor, 2011: An integrated adaptation and mitigation framework for developing agricultural research: Synergies and tradeoffs. *Experimental Agriculture*, **47**, 185-203.
- Jiang**, S., L. Ren, B. Yong, V.P. Singh, X. Yang, and F. Yuan, 2011: Quantifying the effects of climate variability and human activities on runoff from the Laohahe basin in northern China using three different methods. *Hydrological Processes*, **25** (16), 2492-2505.
- JMA**, 2011: *Climate Change Monitoring Report 2010*. Japan Meteorological Agency, Tokyo, Japan, 106 pp.
- Jump**, A.S., T.J. Huang, and C.H. Chou, 2012: Rapid altitudinal migration of mountain plants in Taiwan and its implications for high altitude biodiversity. *Ecography*, **35** (3), 204-210.
- Karimov**, U., A. Kayumov, B. Makhmadaliev, N. Mustaeva, V. Novikov, and I. Rajabov, 2008: *The Second National Communication of the Republic of Tajikistan under the United Nations Framework Convention on Climate Change*. The State Agency for Hidrometeorology, Committee for environmental protection, Dushanbe, Tajikistan, 89 pp.
- Karki**, M., P. Mool, and A. Shrestha, 2009: Climate Change and its Increasing Impacts in Nepal. *The Initiation*, **3**, 30-37.
- Kelkar**, U., K.K. Narula, V.P. Sharma, and U. Chandra, 2008: Vulnerability and adaptation to climate variability and water stress in Uttarakhand State, India. *Global Environmental Change*, **18** (4), 564-574.
- Kharuk**, V.I., K.J. Ranson, S.T. Im, and M.M. Naurzbaev, 2006: Forest-tundra larch forests and climatic trends. *Russian Journal of Ecology*, **37** (5), 291-298.
- Kharuk**, V.I., K.J. Ranson, and M.L. Dvinskaya, 2010a: Evidence of evergreen conifers invasion into larch dominated forests during recent decades. In: *Environmental Change in Siberia: Earth Observation, Field Studies and Modelling* [Balzter, H. (ed.)], pp. 53-65.
- Kharuk**, V.I., K.J. Ranson, M.L. Dyinskaya, and S.T. Im, 2010b: Siberian pine and larch response to climate warming in the southern Siberian mountain forest: tundra ecotone. In: *Environmental Change in Siberia: Earth Observation, Field Studies and Modelling* [Balzter, H. (ed.)], pp. 115-132.
- Khromova**, T.E., M.B. Dyrurgerov, and R.G. Barry, 2003: Late-twentieth century changes in glacier extent in the Ak-shirak Range, Central Asia, determined from historical data and ASTER imagery. *Geophysical Research Letters*, **30** (16), DOI 10.1029/2003gl017233.
- Kim**, B.S., H.S. Kim, B.H. Seoh, and N.W. Kim, 2007: Impact of climate change on water resources in Yongdam Dam Basin, Korea. *Stochastic Environmental Research and Risk Assessment*, **21** (4), 355-373.
- Kim**, M.-K., D.K. Lee, S. Lee, Y. Hong, C.-K. Song, and A.Y. Jeong, 2010: *Korean Climate Change Assessment Report 2010*. Ministry of Environment, National Institute of Environmental Research, Incheon, Korea, 190 pp.
- Kim**, N., 2012: How much more exposed are the poor to natural disasters? Global and regional measurement. *Disasters*, **36** (2), 195-211.
- Kovacs**, K., C. Lydersen, J. Overland, and S. Moore, 2011: Impacts of changing sea-ice conditions on Arctic marine mammals. *Marine Biodiversity*, **41** (1), 181-194.
- Krishnan**, P., S.D. Roy, G. George, R.C. Srivastava, A. Anand, S. Murugesan, M. Kaliyamoorthy, N. Vikas, and R. Soundararajan, 2011: Elevated sea surface temperature during May 2010 induces mass bleaching of corals in the Andaman. *Current Science*, **100** (1), 111-117.
- Kryukova**, V., S. Dolgikh, V. Idrissova, A. Cherednichenko, and G. Sergezina, 2009: *Kazakhstan's Second National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change*. Ministry of Environment Protection, Astana, Kazakhstan, 164 pp.
- Kulkarni**, S. and N. Rao, 2008: Gender and Drought in South Asia: Dominant Constructions and Alternate Propositions. *Droughts and Integrated Water Resource Management in South Asia: Issues, Alternatives and Futures*, **2**, 70.
- Lal**, M., 2003: Global climate change: India's monsoon and its variability. *Journal of Environmental Studies and Policy*, **6** (1), 1-34.
- Lantuit**, H., P.P. Overduin, N. Couture, S. Wetterich, F. Ar , D. Atkinson, J. Brown, G. Cherkashov, D. Drozdov, and D.L. Forbes, 2012: The Arctic Coastal Dynamics Database: A New Classification Scheme and Statistics on Arctic Permafrost Coastlines. *Estuaries and Coasts*, **35**, 383-400.
- Lasco**, R.D., C.M.D. Habito, R.J.P. Delfino, F.B. Pulhin, and R.N. Concepcion, 2011: *Climate Change Adaptation for Smallholder Farmers in Southeast Asia*. World Agroforestry Centre, Laguna, Philippines, 65 pp.
- Li**, Q.X., W.J. Dong, W. Li, X.R. Gao, P. Jones, J. Kennedy, and D. Parker, 2010: Assessment of the uncertainties in temperature change in China during the last century. *Chinese Science Bulletin*, **55** (19), 1974-1982.
- Li**, R.-p. and G.-s. Zhou, 2010: Responses of woody plants phenology to air temperature in Northeast China in 1980-2005. *Shengtaixue Zazhi*, **29** (12), 2317-2326.
- Li**, X., G. Cheng, H. Jin, E. Kang, T. Che, R. Jin, L. Wu, Z. Nan, J. Wang, and Y. Shen, 2008: Cryospheric change in China. *Global and Planetary Change*, **62** (3-4), 210-218.
- Li**, Z., N. Wu, X. Gao, Y. Wu, and K.P. Oli, 2013: Species-level phenological responses to 'global warming' as evidenced by herbarium collections in the Tibetan Autonomous Region. *Biodiversity and Conservation*, **22** (1), 141-152.
- Liang**, T., Q. Feng, H. Yu, X. Huang, H. Lin, S. An, and J. Ren, 2012: Dynamics of natural vegetation on the Tibetan Plateau from past to future using a comprehensive and sequential classification system and remote sensing data. *Grassland Science*, **58** (4), 208-220.
- Lioubimtseva**, E. and G.M. Henebry, 2009: Climate and environmental change in arid Central Asia: Impacts, vulnerability, and adaptations. *Journal of Arid Environments*, **73** (11), 963-977.
- Liu**, D., X. Chen, Y. Lian, and Z. Lou, 2010: Impacts of climate change and human activities on surface runoff in the Dongjiang River basin of China. *Hydrological Processes*, **24** (11), 1487-1495.
- Liu**, S., Y. Ding, D. Shangguan, Y. Zhang, J. Li, H. Han, J. Wang, and C. Xie, 2006: Glacier retreat as a result of climate warming and increased precipitation in the Tarim river basin, northwest China. *Annals of Glaciology*, **43** (1), 91-96.
- Liu**, S., X. Mo, Z. Lin, Y. Xu, J. Ji, G. Wen, and J. Richey, 2010: Crop yield responses to climate change in the Huang-Huai-Hai Plain of China. *Agricultural Water Management*, **97**, 1195-1209.
- Liu**, T., P. Willems, X.L. Pan, A.M. Bao, X. Chen, F. Veroustraete, and Q.H. Dong, 2011: Climate change impact on water resource extremes in a headwater region of the Tarim basin in China. *Hydrology and Earth System Sciences*, **15** (11), 3511-3527.
- Lloyd**, A.H., A.G. Bunn, and L. Berner, 2011: A latitudinal gradient in tree growth response to climate warming in the Siberian taiga. *Global Change Biology*, **17** (5), 1935-1945.

- Ma, T.** and **C. Zhou**, 2012: Climate-associated changes in spring plant phenology in China. *International journal of biometeorology*, **56** (2), 269-275.
- Ma, Z.**, **S. Kang**, **L. Zhang**, **L. Tong**, and **X. Su**, 2008: Analysis of impacts of climate variability and human activity on streamflow for a river basin in arid region of northwest China. *Journal of Hydrology*, **352** (3-4), 239-249.
- Macchi, M.**, **G. Oviedo**, **S. Gotheil**, **K. Cross**, **A. Boedhihartono**, **C. Wolfangel**, and **M. Howell**, 2008: *Indigenous and Traditional Peoples and Climate Change*. 66 pp. http://cmsdata.iucn.org/downloads/indigenous_peoples_climate_change.pdf.
- Marchenko, S.S.**, **A.P. Gorbunov**, and **V.E. Romanovsky**, 2007: Permafrost warming in the Tien Shan Mountains, Central Asia. *Global and Planetary Change*, **56**(3-4), 311-327.
- MEXT**, JMA, and MOE, 2009: *Climate Change and Its Impacts in Japan*. Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan Meteorological Agency (JMA), Ministry of the Environment (MOE), Tokyo, Japan, 74 pp.
- MNPT**, 2000: *Initial National Communication on Climate Change*. Ministry of Nature Protection of Turkmenistan (MNPT), Ashgabat, Turkmenistan, 89 pp.
- Morton, J.F.**, 2007: The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences of the United States of America*, **104** (50), 19680-19685.
- MRC**, 2009: *Adaptation to climate change in the countries of the Lower Mekong Basin: regional synthesis report*. MRC Technical Paper 24 www.mrcmekong.org/.../tech-No24-adaptation-to-climate-change.pdf.
- Myers-Smith, I.H.**, **D.S. Hik**, **C. Kennedy**, **D. Cooley**, **J.F. Johnstone**, **A.J. Kenney**, and **C.J. Krebs**, 2011: Expansion of canopy-forming willows over the twentieth century on Herschel Island, Yukon Territory, Canada. *AMBIO*, **40** (6S1), 610-623.
- Nagai, S.**, **G. Yoshida**, and **K. Tarutani**, 2011: Change in species composition and distribution of algae in the coastal waters of western Japan. In: *Global Warming Impacts - Case Studies on the Economy, Human Health, and on Urban and Natural Environments*. [Casalegno, S. (ed.)]. InTech, Shanghai, pp. 209-237.
- Narama, C.**, **Y. Shimamura**, **D. Nakayama**, and **K. Abdrrakhmatov**, 2006: Recent changes of glacier coverage in the western Terskey-Alatau range, Kyrgyz Republic, using Corona and Landsat. *Annals of Glaciology*, **43**, 223-229.
- Niederer, P.**, **V. Bilenko**, **N. Ershova**, **H. Hurni**, **S. Yerokhin**, and **D. Maselli**, 2008: Tracing glacier wastage in the Northern Tien Shan (Kyrgyzstan/Central Asia) over the last 40 years. *Climatic Change*, **86** (1-2), 227-234.
- Ogawa-Onishi, Y.** and **P.M. Berry**, 2013: Ecological impacts of climate change in Japan: The importance of integrating local and international publications. *Biological Conservation*, **157** (0), 361-371.
- Ohta, S.** and **A. Kimura**, 2007: Impacts of climate changes on the temperature of paddy waters and suitable land for rice cultivation in Japan. *Agricultural and Forest Meteorology*, **147** (3-4), 186-198.
- Olsson, O.**, **M. Gassmann**, **K. Wegerich**, and **M. Bauer**, 2010: Identification of the effective water availability from streamflows in the Zerafshan river basin, Central Asia. *Journal of Hydrology*, **390** (3-4), 190-197.
- Ortiz, R.**, **K.D. Sayre**, **B. Govaerts**, **R. Gupta**, **G.V. Subbarao**, **T. Ban**, **D. Hodson**, **J.M. Dixon**, **J. Iván Ortiz-Monasterio**, and **M. Reynolds**, 2008: Climate change: Can wheat beat the heat? *Agriculture, Ecosystems & Environment*, **126**(1-2), 46-58.
- Osawa, A.**, **Y. Matsuura**, and **T. Kajimoto**, 2010: Characteristics of permafrost forests in Siberia and potential responses to warming climate. In: *Permafrost Ecosystems: Siberian Larch Forests* [Osawa, A., O.A. Zyryanova, Y. Matsuura, T. Kajimoto, and R.W. Wein (eds.)]. Springer, Berlin, pp. 459-481.
- PAGASA**, 2011: *Climate Change in the Philippines*. Philippine Atmospheric, Geophysical and Astronomical Services Administration, Quezon City, Philippines, 85 pp.
- Panday, P.K.** and **B. Ghimire**, 2012: Time-series analysis of NDVI from AVHRR data over the Hindu Kush-Himalayan region for the period 1982-2006. *International Journal of Remote Sensing*, **33** (21), 6710-6721.
- Pavlidis, Y.A.**, **S.L. Nikiforov**, **S.A. Ogorodov**, and **G.A. Tarasov**, 2007: The Pechora sea: Past, recent, and future. *Oceanology*, **47** (6), 865-876.
- Peras, R.J.J.**, **J.M. Pulhin**, **R.D. Lasco**, **R.V.O. Cruz**, and **F.B. Pulhin**, 2008: Climate variability and extremes in the Pantabangan-Carranglan Watershed, Philippines: Assessment of impacts and adaptation practices. *Journal of Environmental Science and Management*, **11** (2), 14-31.
- Piao, S.**, **M. Cui**, **A. Chen**, **X. Wang**, **P. Ciais**, **J. Liu**, and **Y. Tang**, 2011: Altitude and temperature dependence of change in the spring vegetation green-up date from 1982 to 2006 in the Qinghai-Xizang Plateau. *Agricultural and Forest Meteorology*, **151** (12), 1599-1608.
- Post, E.**, **U.S. Bhatt**, **C.M. Bitz**, **J.F. Brodie**, **T.L. Fulton**, **M. Hebblewhite**, **J. Kerby**, **S.J. Kutz**, **I. Stirling**, and **D.A. Walker**, 2013: Ecological consequences of sea-ice decline. *Science*, **341** (6145), 519-524.
- Prentice, M.L.** and **S. Glidden**, 2010: Glacier crippling and the rise of the snowline in western New Guinea (Papua Province, Indonesia) from 1972 to 2000. In: *Altered Ecologies: Fire, Climate and Human Influence on Terrestrial Landscapes* [Haberle, S.G., J. Stevenson, and M. Prebble (eds.)], pp. 457-471.
- Ren, G.**, **Y. Ding**, **Z. Zhao**, **J. Zheng**, **T. Wu**, **G. Tang**, and **Y. Xu**, 2012: Recent progress in studies of climate change in China. *Advances in Atmospheric Sciences*, **29** (5), 958-977.
- Romanovsky, V.E.**, **A.L. Khodolov**, **S.S. Marchenko**, **N.G. Oberman**, **D.S. Drozdov**, **G.V. Malkova**, **N.G. Moskalenko**, **A.A. Vasiliev**, **D.O. Sergeev**, and **M.N. Zheleznyak**, 2008: Thermal State and Fate of Permafrost in Russia: First results of IPY. In: *Ninth International Conference on Permafrost, Vol. 1* [Kane, D.L., and K.M. Hinkel (eds.)]. Proceedings of the Ninth International Conference on Permafrost, June 29 - July 3, 2008, pp.1511-1518.
- Romanovsky, V.E.**, **D.S. Drozdov**, **N.G. Oberman**, **G.V. Malkova**, **A.L. Khodolov**, **S.S. Marchenko**, **N.G. Moskalenko**, **D.O. Sergeev**, **N.G. Ukrainstseva**, **A.A. Abramov**, **D.A. Gilichinsky**, and **A.A. Vasiliev**, 2010: Thermal state of permafrost in Russia. *Permafrost and Periglacial Processes*, **21** (2), 136-155.
- Rosegrant, M.W.**, 2011: *Impacts of climate change on food security and livelihoods*. Food security and climate change in dry areas: proceedings of an International Conference, 1-4 February 2010, Amman, Jordan,24-26.
- Salick, J.** and **N. Ross**, 2009: Traditional peoples and climate change. *Global Environmental Change*, **19** (2), 137-139.
- Sato, Y.**, **T. Kojiri**, **Y. Michihiro**, **Y. Suzuki**, and **E. Nakakita**, 2012: Estimates of Climate Change Impact on River Discharge in Japan Based on a Super-High-Resolution Climate Model. *Terrestrial Atmospheric and Oceanic Sciences*, **23** (5), 527-540.
- Savage, M.**, **B. Dougherty**, **M. Hamza**, **R. Butterfield**, and **S. Bharwani**, 2009: *Socio-Economic Impacts of Climate Change in Afghanistan*. Stockholm Environment Institute, Oxford, UK, 38 pp.
- Shahid, S.**, 2010: Recent trends in the climate of Bangladesh. *Climate Research*, **42** (3), 185-193.
- Sharkhuu, N.**, **A. Sharkhuu**, **V.E. Romanovsky**, **K. Yoshikawa**, **F.E. Nelson**, and **N.I. Shiklomanov**, 2008: Thermal State of Permafrost in Mongolia. In: *Ninth International Conference on Permafrost, Vol. 1* [Kane, D.L., and K.M. Hinkel (eds.)]. Proceedings of the Ninth International Conference on Permafrost, June 29 - July 3, 2008, pp.1633-1638.
- Sharma, H.C.**, **C.P. Srivastava**, **C. Durairaj**, and **C.L.L. Gowda**, 2010: Pest management in grain legumes and climate change. In: *Climate Change and Management of Cool Season Grain Legume Crops* [Yadav, S.S., and R. Redden (eds.)]. Springer Netherlands, pp. 115-139.
- Shrestha, A.B.**, **C.P. Wake**, **P.A. Mayewski**, and **J.E. Dibb**, 1999: Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records from Nepal for the period 1971-94. *Journal of Climate*, **12** (9), 2775-2786.
- Shrestha, A.B.** and **R. Aryal**, 2011: Climate change in Nepal and its impact on Himalayan glaciers. *Regional Environmental Change*, **11**, S65-S77.
- Shrestha, U.B.**, **S. Gautam**, and **K.S. Bawa**, 2012: Widespread climate change in the Himalayas and associated changes in local ecosystems. *PLoS ONE*, **7** (5), e36741-e36741.
- Skoufias, E.**, **M. Rabassa**, and **S. Olivieri**, 2011: The poverty impacts of climate change: a review of the evidence. *World Bank Policy Research Working Paper Series*, Vol.
- Song, Y.**, **H.W. Linderholm**, **D. Chen**, and **A. Walther**, 2010: Trends of the thermal growing season in China, 1951-2007. *International Journal of Climatology*, **30** (1), 33-43.
- Srivastava, A.**, **S. Naresh Kumar**, and **P.K. Aggarwal**, 2010: Assessment on vulnerability of sorghum to climate change in India. *Agriculture, Ecosystems and Environment*, **138** (3-4), 160-169.
- Stokes, C.R.**, **M. Shahgedanova**, **I.S. Evans**, and **V.V. Popovin**, 2013: Accelerated loss of alpine glaciers in the Kodar Mountains, south-eastern Siberia. *Global and Planetary Change*, **101** (0), 82-96.
- Tanner, T.** and **T. Mitchell**, 2008: Entrenchment or Enhancement: Could Climate Change Adaptation Help to Reduce Chronic Poverty? *IDS Bulletin*, **39** (4), 6-15.
- Tao, F.**, **Y. Hayashi**, **Z. Zhang**, **T. Sakamoto**, and **M. Yokozawa**, 2008: Global warming, rice production, and water use in China: Developing a probabilistic assessment. *Agricultural and Forest Meteorology*, **148** (1), 94-110.
- Tao, F.** and **Z. Zhang**, 2010: Adaptation of maize production to climate change in North China Plain: Quantify the relative contributions of adaptation options. *European Journal of Agronomy*, **33**, 103-116.

- Tao, F.** and Z. Zhang, 2013: Climate Change, High-Temperature Stress, Rice Productivity, and Water Use in Eastern China: A New Superensemble-Based Probabilistic Projection. *Journal of Applied Meteorology and Climatology*, **52** (3), 531-551.
- Tchekakova, N., G. Rehfeldt, and E. Parfenova**, 2010: From vegetation zones to climatypes: effects of climate warming on Siberian ecosystems. In: *Permafrost Ecosystems*. Springer, pp. 427-446.
- Thomas, R.J.**, 2008: Opportunities to reduce the vulnerability of dryland farmers in Central and West Asia and North Africa to climate change. *Agriculture, Ecosystems & Environment*, **126** (1-2), 36-45.
- Thomson, A.M., R.C. Izaurralde, N.J. Rosenberg, and X. He**, 2006: Climate change impacts on agriculture and soil carbon sequestration potential in the Huang-Hai Plain of China. *Agriculture, Ecosystems & Environment*, **114** (2-4), 195-209.
- Tian, Y.**, H. Kidokoro, T. Watanabe, Y. Igeta, H. Sakaji, and S. Ino, 2012: Response of yellowtail, *Seriola quinqueradiata*, a key large predatory fish in the Japan Sea, to sea water temperature over the last century and potential effects of global warming. *Journal of Marine Systems*, **91** (1), 1-10.
- Tiwari, P.C. and B. Joshi**, 2012: Environmental Changes and Sustainable Development of Water Resources in the Himalayan Headwaters of India. *Water resources management*, **26** (4), 883-907.
- Tsai, A.-Y. and W.-C. Huang**, 2011: Impact of Climate Change on Water Resources in Taiwan. *Terrestrial Atmospheric and Oceanic Sciences*, **22** (5), 507-519.
- Tsai, A.-Y. and W.-C. Huang**, 2012: Estimation of regional renewable water resources under the impact of climate change. *Paddy and Water Environment*, **10** (2), 129-138.
- van Aalst, M.K., T. Cannon, and I. Burton**, 2008: Community level adaptation to climate change: The potential role of participatory community risk assessment. *Global Environmental Change-Human and Policy Dimensions*, **18** (1), 165-179.
- Vilesov, E.N., V.N. Uvarov, and Anonymous**, 2001: *Evolyutsiya sovremennoy oledeneniya Zailiyskogo Alatau v XX veke (The evolution of modern glaciation of the Zailiyskiy Alatau in the 20th century)* Kazakh State University, Almaty, 252 pp.
- Wade, A.J., E. Black, D.J. Brayshaw, M. El-Bastawesy, P.A.C. Holmes, D. Butterfield, S. Nuimat, and K. Jamjoum**, 2010: A model-based assessment of the effects of projected climate change on the water resources of Jordan. *Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences*, **368** (1931), 5151-5172.
- Wang, B., Q. Bao, B. Hoskins, G.X. Wu, and Y.M. Liu**, 2008: Tibetan plateau warming and precipitation changes in East Asia. *Geophysical Research Letters*, **35** (14), L14702.
- Wang, H.**, 2014: A multi-model assessment of climate change impacts on the distribution and productivity of ecosystems in China. *Regional Environmental Change*, **14**(1), 133-144.
- Wang, H., J. Dai, and Q. Ge**, 2012: The spatiotemporal characteristics of spring phenophase changes of *Fraxinus chinensis* in China from 1952 to 2007. *Science China-Earth Sciences*, **55** (6), 991-1000.
- Wang, J., Y. Hong, J. Gourley, P. Adhikari, L. Li, and F. Su**, 2010: Quantitative assessment of climate change and human impacts on long-term hydrologic response: a case study in a sub-basin of the Yellow River, China. *International Journal of Climatology*, **30** (14), 2130-2137.
- Wang, W., S. Peng, T. Yang, Q. Shao, J. Xu, and W. Xing**, 2011: Spatial and Temporal Characteristics of Reference Evapotranspiration Trends in the Haihe River Basin, China. *Journal of Hydrologic Engineering*, **16** (3), 239-252.
- Warner, K.**, 2010: Global environmental change and migration: Governance challenges. *Global Environmental Change*, **20** (3), 402-413.
- Wu, Q.B. and T.J. Zhang**, 2010: Changes in active layer thickness over the Qinghai-Tibetan Plateau from 1995 to 2007. *Journal of Geophysical Research-Atmospheres*, **115**, 12.
- Wu, R.-F., J.-G. Shen, W.-X. Yan, and H. Zhang**, 2009: Impact of climate warming on phenophase of *Populus tomentosa* in Inner Mongolia. *Chinese Journal of Applied Ecology*, **20** (4), 785-790.
- Wu, X. and H. Liu**, 2013: Consistent shifts in spring vegetation green-up date across temperate biomes in China, 1982-2006. *Global Change Biology*, **19** (3), 870-880.
- Xia, J. and S. Wan**, 2013: Independent effects of warming and nitrogen addition on plant phenology in the Inner Mongolian steppe. *Annals of Botany*, **111** (6), 1207-1217.
- Xu, J., R.E. Grumbine, A. Shrestha, M. Eriksson, X. Yang, Y. Wang, and A. Wilkes**, 2009: The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology*, **23** (3), 520-530.
- Xu, K., J.D. Milliman, and H. Xu**, 2010: Temporal trend of precipitation and runoff in major Chinese Rivers since 1951. *Global and Planetary Change*, **73** (3-4), 219-232.
- Xu, L. and X. Chen**, 2013: Regional unified model-based leaf unfolding prediction from 1960 to 2009 across northern China. *Global Change Biology*, **19** (4), 1275-1284.
- Xu, Z.X., T.L. Gong, and J.Y. Li**, 2008: Decadal trend of climate in the Tibetan Plateau - regional temperature and precipitation. *Hydrological Processes*, **22** (16), 3056-3065.
- Yamano, H., K. Sugihara, and K. Nomura**, 2011: Rapid poleward range expansion of tropical reef corals in response to rising sea surface temperatures. *Geophysical Research Letters*, **38** (4), L04601.
- Yao, T., L. Thompson, W. Yang, W. Yu, Y. Gao, X. Guo, X. Yang, K. Duan, H. Zhao, B. Xu, J. Pu, A. Lu, Y. Xiang, D.B. Kattel, and D. Joswiak**, 2012: Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings. *Nature Climate Change*, **2** (9), 663-667.
- Ye, B.S., D.Q. Yang, K.Q. Jiao, T.D. Han, Z.F. Jin, H.A. Yang, and Z.Q. Li**, 2005: The Urumqi River source Glacier No. 1, Tianshan, China: Changes over the past 45 years. *Geophysical Research Letters*, **32** (21).
- Ye, X., Q. Zhang, L. Bai, and Q. Hu**, 2011: A modeling study of catchment discharge to Poyang Lake under future climate in China. *Quaternary International*, **244** (2), 221-229.
- Yu, H., J. Xu, E. Okuto, and E. Luedeling**, 2012: Seasonal response of grasslands to climate change on the Tibetan Plateau. *PLoS ONE*, **7** (11), e49230.
- Yu, P.-S. and Y.-C. Wang**, 2009: Impact of climate change on hydrological processes over a basin scale in northern Taiwan. *Hydrological Processes*, **23** (25), 3556-3568.
- Yu, Z., P. Sun, S. Liu, J. Wang, and A. Everman**, 2013a: Sensitivity of large-scale vegetation greenup and dormancy dates to climate change in the north-south transect of eastern China. *International Journal of Remote Sensing*, **34** (20), 7312-7328.
- Yu, Z., S. Liu, J. Wang, P. Sun, W. Liu, and D.S. Hartley**, 2013b: Effects of seasonal snow on the growing season of temperate vegetation in China. *Global Change Biology*, **19** (7), 2182-2195.
- Zhang, B., J. Cao, Y. Bai, X. Zhou, Z. Ning, S. Yang, and L. Hu**, 2013b: Effects of rainfall amount and frequency on vegetation growth in a Tibetan alpine meadow. *Climatic Change*, **118** (2), 197-212.
- Zhang, G., Y. Zhang, J. Dong, and X. Xiao**, 2013a: Green-up dates in the Tibetan Plateau have continuously advanced from 1982 to 2011. *Proceedings of the National Academy of Sciences of the United States of America*, **110** (11), 4309-4314.
- Zhang, Q., C.Y. Xu, H. Tao, T. Jiang, and Y.D. Chen**, 2010: Climate changes and their impacts on water resources in the arid regions: a case study of the Tarim River basin, China. *Stochastic Environmental Research and Risk Assessment*, **24** (3), 349-358.
- Zhang, T., J. Zhu, and R. Wassmann**, 2010: Responses of rice yields to recent climate change in China: An empirical assessment based on long-term observations at different spatial scales (1981–2005). *Agricultural and Forest Meteorology*, **150** (7–8), 1128-1137.
- Zhang, Y., D. Guan, C. Jin, A. Wanga, J. Wua, and F. Yuan**, 2011: Analysis of impacts of climate variability and human activity on streamflow for a river basin in northeast China. *Journal of Hydrology*, **410**, 239-247.
- Zhao, J., Y. Zhang, F. Song, Z. Xu, and L. Xiao**, 2013: Phenological response of tropical plants to regional climate change in Xishuangbanna, south-western China. *Journal of Tropical Ecology*, **29**, 161-172.
- Zhao, L., Q.B. Wu, S.S. Marchenko, and N. Sharkhuu**, 2010: Thermal state of permafrost and active layer in Central Asia during the International Polar Year. *Permafrost and Periglacial Processes*, **21** (2), 198-207.
- Zheng, J., S. Zhong, Q. Ge, Z. Hao, X. Zhang, and X. Ma**, 2013: Changes of spring phenophases for the past 150 years over the Yangtze River Delta. *Journal of Geographical Sciences*, **23** (1), 31-44.