

Index

This index should be cited as:

IPCC, 2019: Index. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

Note: * indicates the term also appears in the Glossary and n indicates a footnote. Italicised page numbers denote tables, figures, associated captions and boxed material. Supplementary Material is listed by section number, for example 5.SM.5.1, 6.SM.6.4.1

1.5°C pathway* 22–23, 32n, 195–199, 200–201, 373, 581, 686

1.5°C warming

compared to 2°C 83, 137, 146, 256, 279, 295, 362, 449, 683

crop productivity 454, 680–681

limiting to 22–23, 49, 55, 83, 138, 348, 373, 449

benefits to coastal regions 372

and land-use change 136, 138, 373, 449

risks 15–16, 67, 277, 449, 644, 675, 683, 684, 730

SSP scenarios 50, 67, 278, 675, 684–685, 730

2°C warming

compared to 1.5°C 83, 137, 146, 256, 279, 295, 362, 449, 683

crop productivity 454

limiting to 22, 49, 55, 348

benefits to coastal regions 372

and land-use change 136, 373, 449

pathways 22, 195, 197–199, 200–201

risks 15–16, 683, 684

SSP scenarios 50, 278, 684–686

3°C warming

pathways 22, 701

risks 15–16, 373, 644, 683, 684, 730

SSP scenarios 50, 67, 278, 675, 685, 730

4 per 1000 initiative 387

2030 Agenda for Sustainable Development* 388

A

acceptability (of policy or system change)*

490, 510, 698, 754

acclimation 201–202

acclimatisation* see acclimation

acidification 573–574

ocean acidification 627n, 691

soils 355, 357, 376, 399, 575

see also reduced pollution including acidification

activity data* 160, 164

adaptation* 79, 80, 102–103, 138, 389, 558

agriculture 280, 383, 512

autonomous 466, 512, 701

barriers to 448, 470, 475, 513, 715, 715, 716, 717, 738

challenge 558, 559–561, 561, 564, 565

co-benefits 102–103, 392

community-based 474–475, 518, 566–567

consequences of delay 644–645

costs 693, 711, 723

decision making approaches 721–723

incorporating ILK 512, 747–748

demand-side adaptation 439, 472–473

dietary changes 472–473

ecosystem-based 19, 282, 381, 468, 470, 566–567, 706–707

FAQs 646

financing mechanisms 474, 711–712

food system 439, 440, 441, 470–473, 513

future scenarios 13, 564, 565

gender and 447–448

governance 737–738, 5.SM.5.5

incremental 466, 466, 467, 717, 747

indigenous and local knowledge 512, 746–748

institutional measures 473–475

knowledge gaps 513

and land tenure 751–752

mitigation co-benefits and synergies 22,

102–103, 383, 391, 392

with food security 448, 492, 493, 500, 507,

513–514

near-term actions 33–34

planning 473, 474, 475

policies 27–29, 105–106, 509

risk associated with 686

in shared socio-economic pathways (SSPs)

13, 564, 565

social learning and 749

supply-side adaptation 470–472

synergies with mitigation 448, 492, 493,

499–502, 507, 513–514

technologies 475

transformational 360, 466–467, 466, 467, 717

urban areas 188, 391–393, 392, 505, 507,

706–707

adaptation limits* 714–717

desertification 20, 252–253, 291

land degradation 21, 348, 388

adaptation options* 18–22, 24–26, 81, 589–594, 721–722

adverse side effects 686, 718

agriculture 460, 469, 470–471, 499–502,

589–590

agroecology 468–470, 469, 499–500

agroforestry 382, 383–384

barriers 79

biophysical 470–471

community involvement 403, 474–475, 562

demand-side measures 472–473, 593

diversification 468–470, 469, 589

early warning systems 475

FAQs 107, 646, 755

financial instruments 474, 475

flexible livelihoods 471

food system 464–475, 467, 509, 513–514

gender and 718

global potential 24–26

indigenous and local knowledge 469, 470, 512

institutional 473–475

migration 285, 380, 466, 683

reducing meat consumption 472–473

region-specific 107, 469, 561–563, 591, 592

risk management 467–468, 594

soil management 470–471, 591–592

supply-side measures 470–472, 593, 594

sustainable food systems 465–466

sustainable integrated agricultural systems 499–502

sustainable land management (SLM) 388, 465

synergies and trade-offs 492, 493, 499–502, 686, 718

transport and trade 471–472

urban green infrastructure (UGI) 391–393, 392, 563

water management 471

adaptation pathways* 104, 721–722, 743

adaptation potential 589–594, 609–610, 609, 611–617, 7.SM.7.1

agricultural response options 589–590, 590, 611

demand management options 593, 593, 615

forest response options 590, 590, 612

land management options 589–592, 611–615

all/other ecosystems 591–592, 592, 614

specifically for CDR 592, 592, 615

risk management options 594, 594, 617

soil-based response options 591, 591, 613

supply management options 593, 594, 616

adaptive capacity* 16, 557, 717, 736–737, 753, 754

by continent 5.SM.5.2

corruption and 716

culture and beliefs 470

dryland areas 16, 753

enhancing 22, 28, 104, 107, 701

forested areas 103

indigenous people 470, 755

inequality and 716

insurance and 594, 699

knowledge and 104, 755

land tenure and 27

mitigation and 103

oasis populations 301–302

pastoralists 22, 276, 448

in shared socio-economic pathways 13, 14, 92–93

smallholders 22

strengthening 286–288

sustainable sourcing and 578, 616

to floods 701

transformational 466–467

vulnerable groups 104, 518, 691

women 353, 448, 716, 717

adaptive governance* 723, 737, 742–743, 743–745

inclusive 754

indicators/institutional dimensions 753, 754

social-ecological systems 391

adaptive institutions 736–737

adaptive management 68, 351, 721, 723–725, 724, 745

adaptive risk management (ARM) 639

adverse side effects* 19, 609, 611–615, 625

adaptation options 686, 718

afforestation 374, 605, 612

biochar 399, 613

- bioenergy and BECCS 373–374, 581–582, 592, 615, 687
- coastal protection measures 402–403
- forest area expansion 97, 99, 100
- of mitigation 138
- on NCPs or SDGs 630
- peatland restoration/reduced conversion 614
- reducing deforestation and forest degradation 562
- reducing grassland conversion to cropland 611
- reforestation and forest restoration 605, 612
- risk from 687–688
- AerChemMIP (Aerosol Chemistry Model Intercomparison Project)** 169
- aerosols*** 139, 166–170, 268–269, 269, 271, 293
- carbonaceous aerosols 149, 167–169, 573
- deposition on snow 166, 269
- fire emissions 149, 573, 683
- net cooling effect of dust emissions 377
- secondary organic aerosols (SOA) 166, 167, 169, 170
- transport 269, 271
- afforestation*** 19, 385–386, 567, 572
- adaptation potential 590, 590
- adverse side effects 374, 605, 612
- best practice 25
- CO₂ emissions 45, 155
- combined with bioenergy and BECCS 637
- compensatory afforestation 710
- defined 98
- feasibility 620, 6.SM.6.4.1
- global potential 25
- green walls/dams 294–296, 297
- impact of delayed action 645
- impact on desertification 596, 596
- impact on food security 605, 605
- impact on land degradation 374–375, 385–386, 600, 600
- impact on NCP 628, 6.SM.6.4.3
- impact on SDGs 631, 6.SM.6.4.3
- increasing 385–386
- interlinkages 636–637
- Karapinar wind erosion area 293, 293
- mitigation potential 191, 196, 585, 585, 637
- policy instruments 726
- potential across land challenges 610, 612
- risk of land degradation 374
- sensitivity to climate change impacts 623–624
- short-term static abatement costs 102
- side effects and trade-offs 97, 99
- water balance 98
- afforestation/reforestation** 8–9, 191, 492
- future scenarios 198–199, 373
- land type used 374–375
- mitigation potential 48, 49
- AFOLU (agriculture, forestry and other land use)*** 8–11, 138, 151
- CH₄ emissions/removals 8, 11, 151, 159–160, 160
- CO₂ emissions/removals 8–9, 133–134, 151, 152–155, 152, 153, 154, 156, 157
- emissions 151, 151, 152, 157
- food system emissions 10–11, 475–476
- GHG emissions 8–11, 10–11, 82–83, 133–134, 151, 154, 156
- gross CO₂ flux 134, 152, 157
- mitigation 199, 480
- N₂O emissions/removals 8, 11, 133, 134, 151, 160–162, 161, 163
- net anthropogenic emissions 8–11, 10–11, 133–134, 151
- net CO₂ flux 133–134, 152–153, 152
- regional differences in emissions 155, 156
- total net GHG emissions 11
- Africa**
- agricultural emissions 159
- charcoal production 375, 740–741
- conflict 380
- conservation agriculture 501
- crop production 300–301, 452–453, 454, 682
- deforestation 185
- desertification 263, 305
- drought 258–259, 276, 290–291, 682–683
- dryland areas 255, 682–683
- dryland population 256–258, 257
- dust emissions 166, 167, 268–269
- floods 744
- food loss and waste 100–101, 682
- food security 450, 465–466, 472
- Great Green Wall of the Sahara and the Sahel 296, 297
- Green Dam project in Algeria 295–296, 296
- invasive plants 262, 298
- irrigation 180, 288–289
- land degradation 263, 375, 380
- land tenure 287, 750, 751
- Limpopo River basin 263, 305
- oases 300–302, 300, 302
- pastoralists 276
- poverty in dryland areas 257
- rainfall erosivity in Niger Basin 370
- rainfall patterns 176, 180, 186, 258, 305, 450, 451
- river basin degradation 263, 305, 370
- sustainable food systems 465–466
- traditional biomass 375
- urbanisation 285
- vegetation greening 263
- water scarcity 301, 682–683
- agreement*** 4n, 26
- agricultural commercialism** 289
- agricultural diversification** 567, 570
- adaptation potential 589, 590
- feasibility 619, 6.SM.6.4.1
- impact on desertification 595, 595
- impact on food security 604, 604
- impact on land degradation 599, 600
- impact on NCP 628, 6.SM.6.4.3
- impact on SDGs 631, 6.SM.6.4.3
- mitigation potential 584, 584
- policy instruments 726
- potential across land challenges 610, 611
- sensitivity to climate change impacts 623
- smallholders 640
- agricultural intensification** 195, 197, 502, 562, 583
- adverse effects 252–253, 276, 291–292, 735
- future pathways 30, 195, 642
- global 5.SM.5.5
- sustainable 481–482, 501–502, 502–505, 566–567, 583, 589
- agricultural land**
- BVOC emissions 170
- CO₂ emissions 376
- degradation 352, 373, 376, 402
- global trends in land use 444
- intensive management 373
- land use/cover change 642
- see also croplands; pasture
- agricultural productivity** 379, 379, 603–604
- impact of desertification and climate change 273, 276, 279
- livestock 454–458, 455
- see also crop productivity; crop yields
- agricultural response options** 100, 189, 569–571, 610
- adaptation potential 589–590, 590, 611
- feasibility 619, 6.SM.6.4.1
- impact on desertification 595, 595, 611
- impact on food security 603–604, 604, 611
- impact on land degradation 599, 600, 611
- impact on NCP 628, 6.SM.6.4.3
- impact on SDGs 631, 6.SM.6.4.3
- mitigation potential 189, 583–584, 584, 611
- potential across land challenges 611
- sensitivity to climate change impacts 623
- synergies and trade-offs 733
- agricultural services** 286–287
- agriculture**
- adaptation and mitigation 103, 470–471, 733
- adaptation policies 473
- agricultural expansion 481–482
- agronomic practices 381, 382–383
- best practice 723
- climate-smart agriculture 474, 500, 563, 565–566, 566–567, 733, 751, 5.SM.5.5
- CO₂ land-atmosphere exchange 376
- conservation agriculture 100, 192, 281, 470, 471, 500–501
- controlled traffic farming 503
- dependency 5.SM.5.2
- desertification and 273, 276, 279, 279–283
- diversification 468, 469, 504, 589
- dryland areas 16, 257, 259
- emissions pricing 702, 703
- energy crops 374
- energy efficiency 579
- extensification 511
- financing mechanisms 712
- flooding 147–148
- GHG emissions 159, 160, 160, 161, 376, 475–478, 511, 702, 703
- croplands and soils 159–160, 161, 162, 163, 476, 477
- enteric fermentation 160, 189, 477
- global trends 444, 445, 496
- livestock 159, 160, 161, 162, 476, 477–478, 478
- rice cultivation 159, 160, 477
- see also AFOLU

- GHG fluxes 376
 GHG mitigation 190, 480–486
 global status and trends 85–88, 87
 Hindu-Kush Himalayan Region 469
 impacts of climate change 373, 451–460, 461
 impacts of precipitation extremes 147–148
 improved efficiency 503
 improved market access 286
 indigenous and local knowledge (ILK) 283–284, 381, 384, 747
 institutional adaptation options 473
 integrated agricultural systems 499–502, 504
 intensification
 see agricultural intensification
 invasive plants impacts 298, 299
 land degradation 372, 376
 land use 82–83, 85–86, 87
 large-scale land acquisition (LSLA) 91, 750, 751
 maladaptation 734
 mitigation barriers 715, 716
 mixed farming 384, 500
 mountain agriculture 301, 469
 nitrogen fertilisation 159
 no-till farming 292, 376, 383, 471, 686
 oasis agriculture 300–301
 Pacific island communities 517, 518
 pastoralism 257, 276, 384
 perennial grains and SOC 392, 393–395
 policies 286–287, 473, 482, 508, 697, 701–702, 703, 714
 precision agriculture 100, 503, 566–567
 re-vegetation of saline land 283
 research and development 697
 resilience 591
 response options, mitigation potential 189
 rice cultivation 384
 risk management 102
 smallholder farming systems 459–460, 499–500, 593, 594, 697
 smallholder plantations 397–398
 standards and certification schemes 707–709, 708
 sustainable farming systems 381, 384, 465–466
 sustainable land management 100
 synergies 731
 urban and peri-urban agriculture 188, 505, 507
 vulnerability 5.SM.5.2
 water use 7.SM.7.1
 see also AFOLU; agricultural response options; agroforestry; irrigation
- agriculture, forestry and other land use**
 see AFOLU
- agrobiodiversity*** 468
- agroecology*** 381, 499–500, 566–567
 food systems and 468–470, 469
- agroforestry*** 280, 382, 383–384, 567, 570
 adaptation potential 589, 590
 carbon sequestration potential 485
 co-benefits 504
 feasibility 618, 619, 6.SM.6.4.1
 and food systems 470, 485, 504
 GHG mitigation 485, 485
 impact on desertification 595, 595
- impact on food security 604, 604
 impact on land degradation 599, 600
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 mitigation potential 189, 584, 584
 policy instruments 726
 potential across land challenges 609, 610, 611
 potential deployment area 633
 sensitivity to climate change impacts 623
- agronomic response measures** 381, 382–383, 382
- agropastoralists** 257, 439, 455–456, 5.SM.5.1
- air pollution** 160, 187–188, 590
 from fire 683
 indoor 288, 709, 740
 management 573–574
 short-lived climate pollutants* 451, 586, 740
 urban 187–188, 603, 691
 see also reduced pollution including acidification
- Alaska** 743
- albedo*** 139
 aerosol deposition and 166
 albedo-induced surface temperature changes 172
 croplands 181–182, 181
 deforestation and 177
 forest management 191–192
 forest vs. non-forest 98
 impact of afforestation 374
 impact of biochar 399
 land cover changes 12, 172, 374
 land degradation and surface albedo change 377
 radiative forcing from changes in 138
 seasonal vegetation change 139
 snow-albedo feedback 178, 179, 183–184
 surface albedo change and feedbacks to climate 182–184, 269–270
- Algeria** 263, 301
 Green Dam project 295–296, 296
- Amazon**
 biodiversity 352
 BVOC emissions 169
 deforestation 106, 149, 175, 185, 481–482
 deforestation and malaria 691
 drought 146
 drought induced fires 149, 155
 global warming and local climate feedbacks 45, 183, 183
 land rights 106, 378
 peatlands 397–398
 REDD+ 709–710
- Amazon biome** 481
- ammonia (NH₃)** 376, 497, 5.SM.5.3
- animal feed** 276, 473, 485, 5.SM.5.3
- anthromes*** 279–280, 280, 558, 559
 area exposed to land challenges 560
 defined 86
 local response to land challenges 561–563
 overlapping land challenges 558, 560, 561, 561, 561–563
- anthropogenic*** defining 155
- anthropogenic drivers**
 of coastal degradation 354, 402–403
 of desertification 251, 259–260, 264, 268
 interaction with climate change 259–260, 382
 of land degradation 349, 354–355
- anthropogenic emissions*** 8–9, 10–11, 11, 41, 44, 45–46, 84, 151, 152–155, 199, 349
 aerosols 166, 167, 168–169, 170
 carbon dioxide (CO₂) 152–155, 152, 154, 156, 157
 estimating 153–155, 154, 163–164
 gross emissions 157
 methane (CH₄) 159–160, 160
 nitrous oxide (N₂O) 160–162, 161
 rapid reduction 34, 79
 regional trends 155, 156
 separating from non-anthropogenic 151, 199
 see also greenhouse gas emissions
- anthropogenic removals*** 8, 46, 152–155, 157, 188
 estimating 153–155, 154
 negative emissions technologies 348, 398, 399, 441, 492
 see also carbon dioxide removal (CDR)
- anthropogenic warming** 133, 147, 175
- anticipatory governance** 724, 742
- aquaculture** 697
 adaptation options 471
 GHG emissions 162, 478
 GHG mitigation 486–487
 impacts of climate change 459
- AR5** see IPCC Fifth Assessment Report
- Arabian Peninsula** 258, 274
 oases 300–302, 300
- Aral Sea** 264, 293, 294
- Arctic region**
 permafrost thaw 684, 689, 7.SM.7.1
 sea ice 179, 691
 soils 204
 vegetation increase 377, 456
 warming 168, 172, 362, 377, 564
- Argentina** 265, 452, 481
- arid ecosystems** 252, 271, 595
- aridity*** 142
 aridity index (AI) 254, 254, 260
 future projections 276–277
- Asia**
 agricultural emissions 159
 black carbon emissions 168
 crop production and food security 452
 deforestation and rainfall patterns 185
 desertification and land degradation 263–264
 dryland areas 255
 dryland populations 257, 257
 floods 472, 744
 greening trend 263
 Hindu-Kush Himalayan region 452
 invasive plants in Pakistan 299–300
 land tenure 751
 monsoon rainfall 176
 pastoral systems 456
 peatland degradation 397–398
 peatland fires 397

- reforestation in South Korea 395–396
 - river basin degradation 263
 - soil erosion in Central Asia 293–294
 - Sundarbans mangroves 400
 - traditional biomass use and land degradation 375
 - see also China
 - atmosphere*** 185–186
 - atmospheric CO₂** 79, 84–85, 140, 171, 172, 184, 254
 - changes in 7.SM.7.2
 - desertification feedbacks to climate 268, 269
 - effect of increasing levels 88, 144, 165
 - on crops 451–452, 453, 454, 458, 463–464
 - on food quality 463–464
 - on livestock 454–455, 455, 456
 - on soil organic carbon 134, 204
 - on vegetation 79, 134, 144, 165, 202–203, 251, 297, 362, 457, 463
 - forestation and 179
 - impact on food security 5.SM.5.2
 - increase due to land cover change 172–173, 174, 174
 - potential impact of mitigation 157
 - regional warming due to increase 135, 172–173, 173, 174, 174
 - removal 133–134, 135–136, 157, 492, 494
 - see also CO₂ fertilisation
 - atmospheric inversions** 164
 - attribution***
 - desertification 265–268
 - land degradation 360, 362
 - soil erosion 682
 - of vegetation changes to human activity 266
 - Australia**
 - climate change and crop production 452
 - desertification 264
 - dryland areas 255
 - dryland population 257
 - mesoscale convective systems (MCS) 370
 - monsoon rainfall 176
 - autonomous adaptation*** 466, 512, 701
- B**
- Bangkok flood** 472
 - Bangladesh** 698, 744
 - barren lands** 560, 561, 561
 - barriers** 28, 34, 42
 - economic 42, 618, 619–623, 715, 6.SM.6.4.1
 - environmental 619–623, 6.SM.6.4.1
 - geophysical 619–623, 6.SM.6.4.1
 - inequality as 716
 - institutional 618, 619–623, 715–716, 715, 737, 738, 6.SM.6.4.1
 - multiple 62
 - overcoming 34, 70, 103, 513, 717
 - region specific 292
 - socio-cultural 42, 618, 619–623, 715, 6.SM.6.4.1
 - technological barriers 62–63, 618, 619–623, 715, 6.SM.6.4.1
 - to adaptation 448, 470, 475, 513, 715, 715, 716, 717, 738
 - to addressing desertification 292
 - to addressing land degradation 55
 - to community-based adaptation 475
 - to early warning systems 475
 - to implementing policy response 28, 43, 714–717
 - to implementing SLM 28, 284, 389–391
 - to integrated response options 618, 619–623, 6.SM.6.4.1
 - to mitigation 79, 188, 292, 513, 715–716
 - to participation and decision making 717–718
 - to urban agriculture 188
 - baseline scenario*** 195–196, 197, 564, 565, 684
 - baseline values** 260, 350, 365
 - baseline-and-credit schemes** 703
 - BECCS (bioenergy with carbon dioxide capture and storage)*** 196, 198–199, 373, 492, 494, 513–514
 - large land-area need 19, 97
 - mitigation potential 49, 193, 201, 494
 - risks of 686–688, 687
 - see also bioenergy and BECCS
 - behavioural change** 95, 291, 390, 645
 - best practice** 25, 391, 707, 723
 - Biennial Transparency Reports** 704
 - bio-economic farm model (BEFM)** 460
 - bioaerosols** 168
 - biochar*** 100, 392, 398–400, 492, 573
 - adaptation potential 493, 591, 591
 - best practice 25
 - combined with other response options 374, 567
 - demand for land 19, 610
 - feasibility 620, 6.SM.6.4.1
 - global potential 25
 - impact on desertification 596, 596
 - impact on food security 605, 606
 - impact on land degradation 374, 399–400, 601, 601
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 192–193, 399, 493, 585–586, 586
 - mitigation, role in 398–399
 - negative effects 399, 610
 - policy instruments 726
 - potential across land challenges 610, 613
 - production 192, 398, 400, 605, 741
 - sensitivity to climate change impacts 624
 - bioclimates** 141
 - biodiversity*** 79
 - agroecosystems 504
 - drylands 271–272, 278–279
 - forest 98–99, 352
 - future scenarios 564, 565
 - green energy and 735
 - impact of bioenergy 97
 - impact of climate change 404
 - impact of desertification 263, 271–272, 278–279
 - impact of forest area expansion 98–99
 - impact of grazing and fire regimes 281–282
 - impact of invasive plant species 297–300
 - loss 19–20, 88, 263, 683
 - risk to 691
 - SLM practices and 306
 - threatened hotspots 558, 559, 560, 562
 - trade-offs 730–731, 735
 - biodiversity conservation** 567, 575, 706–707
 - adaptation potential 592, 592
 - combined with bioenergy and BECCS 637
 - feasibility 621, 6.SM.6.4.1
 - impact on desertification 597
 - impact on food security 606, 606
 - impact on land degradation 601, 601
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 586, 587
 - policy instruments 726
 - potential across land challenges 614
 - sensitivity to climate change impacts 624
 - bioenergy*** 19, 288, 492, 494, 646
 - agricultural and food waste streams 486, 741
 - alternative land use to livestock production 511
 - biomass supply 97, 193–194, 373–374, 375, 386, 581
 - competition for land 42, 53–54, 62, 99, 607
 - cropland 30–32, 31–32, 62, 194, 196, 199, 642–644, 646
 - crops 97, 193–194, 373–374, 492, 576, 646
 - energy access 709
 - GHG emissions 49, 193–194, 196, 583
 - global consumption 582
 - governance 738–739
 - impacts on land degradation 373–374
 - land area required 19, 97, 687–688, 687, 739, 7.SM.7.1, 7.SM.7.3
 - modelled pathways 22–23, 30–32, 49, 97, 373, 449
 - mitigation potential 193–194, 201
 - potential scale 373
 - reducing/reversing land degradation 374–375
 - risks due to 373–374, 686–688, 687
 - risks under different SSPs 7.SM.7.1, 7.SM.7.3
 - short term net emissions 193–194
 - socio-economic impacts 739
 - sustainability standards and certification 707, 708, 709
 - synergistic outcomes 582
 - technology transfer 704
 - trade-offs with SDGs 7.SM.7.1
 - traditional biomass 20, 288, 375, 709, 740–742
 - bioenergy and BECCS** 19, 193–194, 567, 575–576, 580–583
 - adaptation potential 592, 592
 - adverse side effects 581–582, 592, 615
 - best practice 25, 707
 - co-benefits 581–582, 592, 615
 - feasibility 618, 621, 6.SM.6.4.1
 - global potential 25–26
 - impact of delayed action 645
 - impact on desertification 597, 597
 - impact on food security 607, 607
 - impact on land degradation 373, 601, 602
 - impact on NCP 628, 6.SM.6.4.3

- impact on SDGs 631, 6.SM.6.4.3
 - interlinkages and interactions with other
 - response options 636–638, 636, 637
 - inventory reporting 583
 - limiting 637–638
 - mitigation potential 193, 580–583, 587, 587, 637
 - modelled pathways 22–23, 72–74, 97, 373, 494
 - mitigation scenarios 196–199, 580–583
 - policy instruments 726
 - potential across land challenges 610, 615
 - potential deployment area 633, 633
 - risks due to 686–688, 7.SM.7.1, 7.SM.7.3
 - scale of deployment 62, 63, 67
 - sensitivity to climate change impacts 624
 - biofuel*** 288, 486, 580–583
 - crops 193–194, 283
 - governance 738–739
 - sustainability 708, 709
 - biogenic volatile organic compounds (BVOCs)** 169–170
 - contribution to climate change 170
 - decrease in emissions 192
 - future trends 170
 - oxidation 168, 169, 170
 - and tropospheric ozone 170
 - biogeochemical effects*** 134–135, 136, 139, 140, 173, 174, 175
 - aerosols deposition and 166
 - changes in anthropogenic land cover 243, 243–247
 - cooling 179
 - deforestation/forestation 98, 176–177, 178–180
 - dynamics of soil organic carbon 203
 - forest response options 191–192
 - global warming 172, 174–175, 177
 - regional warming 172–173
 - warming 135, 176–177, 179
 - biogeochemical models** 158
 - biological soil crusts** 356, 358
 - biomass*** 580–583
 - for bioenergy 19, 193–194
 - Biomass Production Efficiency (BPE) 368
 - burning 162, 168, 169, 7.SM.7.1
 - burning emissions 162, 168, 169
 - feedstock 399, 605, 610
 - field measurements 163
 - fuelwood 288
 - harvested 86, 351, 352
 - potentials 581
 - resource management 739
 - sustainability standards and certification 707–709, 708
 - traditional biomass 20, 288, 375, 709, 740–742
 - water content 262
 - biomes*** 141, 279–280, 280
 - Amazon biome 481
 - biome shifts 140, 371, 684, 7.SM.7.1
 - biophysical effects*** 135, 139, 173, 174, 175
 - bioenergy deployment 194
 - changes in anthropogenic land cover 135, 243, 243–247
 - cooling 172–173, 174–175, 177, 178, 179
 - deforestation/forestation 98, 176–180
 - forest response options 191–192
 - global 172, 174–175, 177, 178, 179
 - regional 172–173, 174, 175–176, 177–178, 179
 - seasonal 178–179
 - warming 172, 174, 175, 177–178, 179, 197
 - biophysical models** 262, 364, 366
 - biotic degradation processes** 355–356, 371–372
 - black carbon (BC)*** 167, 168, 451, 591, 606, 740
 - blockchains** 513
 - Bolivia** 452
 - bookkeeping/accounting models** 9, 152–155, 154, 163
 - boreal forest** 15, 179–180, 191
 - climate related risks 7.SM.7.1
 - shift to woodland/shrubland 7.SM.7.1
 - boreal regions** 12
 - area burned by fires 156
 - BVOC emissions 169
 - climate feedbacks 182–183, 182, 183
 - deforestation 177, 179
 - evolution of natural vegetation 172
 - fires 148–149, 150
 - forest management 191–192
 - forestation 177, 179, 191
 - peatlands 397, 398
 - water use efficiency 165
 - Botswana** 287
 - Brazil** 482, 562, 582
 - Bromus tectorum* (Cheatgrass)** 299
 - Brossentia papyrifera* (Paper Mulberry)** 299
 - brown carbon (BrC)** 167, 168
 - buffelgrass** 299
 - Burkina Faso** 263
 - burning embers diagrams** 14, 680, 681, 685, 687, 7.SM.7.1–3
 - bush encroachment** see woody encroachment
 - business as usual (BAU)*** 199, 200
- ## C
- Canada**
 - fire 149, 684
 - floods 744
 - canopy cover** 367, 368, 369
 - cap and trade systems** 702
 - capabilities** 557–558
 - capital markets** 511
 - carbohydrate dilution** 463
 - carbon balance** 191, 193, 201–202
 - carbon budget*** 485, 573
 - global carbon budget 157, 385
 - carbon capture and storage (CCS)*** 99, 373
 - carbon cycle*** 84
 - future terrestrial carbon source/sink 137
 - impact of desertification 268
 - impact of extreme rainfall 148
 - impact of fire 149
 - impact of heat extremes and drought 146
 - impact of land degradation 376
 - peatlands, wetlands and coastal habitats 193
 - rebound effect 157
 - wild animal management and 586
 - carbon dioxide (CO₂)*** 8–9, 10–11, 152–157
 - 4p1000 initiative 387
 - biogeochemical effects of land use change 171–173, 173, 174–175, 174, 175, 176–177, 177, 243, 243–245
 - CO₂ equivalent emissions 151
 - cumulative emissions 243, 243–245
 - emission reduction and removal 195–197, 196, 485
 - emissions 79, 82–83, 89, 133–134, 137, 151
 - due to deforestation 153, 176–177, 177, 476
 - due to land degradation 153, 376–377
 - due to land use change 195–196, 476
 - fire emissions 149, 586
 - food system emissions 475–476, 477, 478
 - fossil fuel emissions 153, 153
 - peatland emissions 159, 397, 476, 477
 - soil emissions 134, 203
 - transport emissions 478
 - estimating emissions 134, 153, 155
 - fluxes 87, 88, 154
 - AFOLU fluxes 8–9, 133–134, 151, 152–155, 152, 153, 154, 156, 157
 - anthropogenic land flux 8–9, 133–134, 151, 154, 156, 163–164
 - forest fluxes 154
 - LULUCF fluxes 199–200, 200
 - total net land-atmosphere flux 8, 133–134, 152–157, 152
 - gross emissions/removals 134, 152, 157
 - land cover change and 8–9, 10–11, 133–134, 151, 172, 243, 243–245
 - land sink processes 153, 155–156, 157
 - negative emissions 135–136, 198–199
 - net anthropogenic flux due to land cover change 8–9, 10–11, 133–134, 151, 156
 - net emissions 6–7, 8, 154, 171
 - net FOLU emissions 6–7
 - net negative emissions 198
 - non-AFOLU emissions 10–11, 151, 153, 155
 - permafrost release of 134, 184
 - release from deep soil 203
 - sequestration through forest area expansion 99
 - sink 84, 87, 172, 180, 182, 397
 - see also atmospheric CO₂; carbon dioxide removal (CDR); CO₂ fertilisation
 - carbon dioxide removal (CDR)*** 135–136, 492, 494
 - future pathways 22–23
 - increased need 645
 - land area needed for 373
 - land management response options 97
 - mitigation pathways 196–197, 196, 198–199
 - Paris Agreement 449
 - potential scale 373
 - reducing/reversing land degradation 374–375
 - risk of land degradation 373–374
 - sustainable forest management (SFM) and 386–387
 - synergies and trade-offs 492, 493, 494
 - Carbon Disclosure Project** 511
 - carbon footprint** 479, 491, 505, 511
 - carbon intensity*** 702

- carbon monoxide (CO)** 149
- carbon pools** 84, 191, 368
conservation of 191, 571
and erosion 376
permafrost 184
- carbon price*** 645, 694, 701, 702, 753
- carbon rights** 715, 716
- carbon sequestration*** 18, 84, 281, 715
agroforestry 485, 485
aquaculture 486–487
coastal wetlands 193
compensation by albedo changes 377
cropland soils 192, 483
decrease 147
dryland areas 271
forests 191, 385–386
grasslands and rangelands 483
grazing lands 192
impact of fire 149
impact of heat extremes and drought 146, 147
land degradation 376
nitrogen deposition and 203
projected 278
- carbon sink*** 351, 352, 368
enhancing 388
forests 21, 156, 180, 386
future trends 137
impacts of heat extremes and drought 146
importance of arid ecosystems 271
land sink process 153, 155–157
loss of 689
reversal 686
- carbon stocks*** 351, 352
desertification and 270, 271
forest carbon stocks 191, 351, 352, 367, 368–369, 385–387
modelling 201
peatlands 397, 398
vulnerability to extreme events 147
- carbon tax** 68, 498, 510, 702, 714, 753
policy in SSPs 727
- carbonaceous aerosols** 149, 167–169, 573
- cascading impacts** 354, 376, 682, 690, 691, 744, 755
- cascading risks** 15, 679
- case studies**
avoiding coastal maladaptation 392, 402–403
biochar 392, 398–400
climate change and soil erosion 292–294
climate smart villages in India 563
conservation agriculture 561–562
degradation and management of peat soils 392, 397–398
desertification 292–305
flood and food security 743–745
governance of biofuels and bioenergy 738–739
green energy trade-offs with biodiversity and ES 735
green walls/dams 294–296, 297
integrated watershed management (IWM) 302–305, 303, 304
interlinkages between land challenges 561–563
invasive plant species 297–300, 298
- New Zealand Emissions Trading Scheme (ETS) 703
oases in hyper-arid areas 300–302, 300, 302
overlapping land challenges 561–563
pasture intensification 562
perennial grains and SOC 392, 393–395
REDD+ in Amazon and India 709–711
reforestation 392, 395–397
saltwater intrusion 392, 401–402
soil and water conservation 561–562
tropical cyclone damage 392, 400–401
tropical forests restoration and resilience 562
urban green infrastructure (UGI) 391–393, 392, 563
- catastrophe (CAT) bonds** 713
- catastrophe risk pool** 713
- cellular agriculture** 487
- Cenchrus ciliaris* L. (Buffelgrass)** 299
- Central America** 265, 460, 518
- Central Asia** 264, 293–294
- Cerrados, Brazil** 562
- certification schemes** 602, 707–709, 708
- CFS (Committee on World Food Security)** 5.SM.5.5
- charcoal** 375, 740–741
- cheatgrass (*Bromus tectorum*)** 299
- childhood stunting** 445, 445, 446, 607
- childhood wasting** 445, 445, 446, 607
- Chile** 265, 292
- China**
afforestation programmes 98, 294–295
crop production 452
desertification and land degradation 263, 294–295, 396, 603
dust storms 294–295
land degradation control policies 396–397
reforestation 396–397
rice cultivation 452
sand movement and railways 275
Sloping Land Conversion Program 603
- citizen engagement** 754
- citizen science*** 512, 748
- civil society organisations (CSOs)** 5.SM.5.5
- Clean Development Mechanism (CDM)*** 704
- climate***
climate zone shifts 8, 15, 133, 140, 143, 205
desertification feedbacks to 268–270, 269
dust and 166–167
effect on land sink 155–156
future pathways 641–644
global impacts of land cover change 171–172, 171, 172, 173, 174–175, 175, 182
impact of deforestation/forestation 176–180
impact of land condition changes 12, 134–135, 171–186
local effects 180, 377
non-local and downwind effects 135, 180, 184–186, 185
novel unprecedented climates 143
projections* 140, 176, 184, 277
regional see regional climate
seasonal 173, 178, 179, 572
see also climate system
- climate change*** 7–8, 79–80, 133, 171, 175, 756
amplification 172, 178, 377
biogeochemical warming 172–173, 173, 174
biophysical cooling 172–173, 173, 174–175, 174, 175
BVOC contribution to 170
capacity to respond 80
desertification and 251–252, 258–260
dust emissions and 167
equity 446–447, 447–448
financial impacts and instruments for managing 712–713
fire and 148–150
food security and 439–440
future scenarios 564, 565
gender and 104–105, 446–447, 447–448
impacts see climate change impacts
increasing risks and impacts 14–15, 15–17
and indigenous food systems 469
influence on land use 90–91
land challenges and response options 553–555
land degradation in the context of 347–348, 353–365
land tenure and 749–750
observed change 82–83
reducing negative impacts 79
risk management and decision making for sustainable development 675–677, 678
risk transitions 14, 680–688, 7.SM.7.1–3
role of ILK in understanding 746–747
socio-economic challenges 81
sustainable development pathways 678
upper atmosphere effects 185
- Climate Change Adaptation (CCA)** 467
see also adaptation
- climate change impacts** 84–85, 89–90, 90, 623–624
agriculture 373, 451–460, 461, 623
crop production 8, 380, 451–454, 458–459, 5.SM.5.2
livestock 276, 454–458, 455, 5.SM.5.2
pastoral systems 276, 455–458, 5.SM.5.1
analysis methods 460
aquaculture 459
aridity 142
biodiversity 404, 624
climate change impact-land management interactions 351, 352
conflict 380–381
desertification 7–8, 258–260
direct effects on plant and animal biology 463
dust emissions and dust storms 167, 277
ecosystem services 404
energy infrastructure 275
feedbacks to climate 12, 171–180, 182–185
food prices 460–462, 461, 494–497, 495, 685–686
food security 7–8, 15, 142–143, 442, 443, 450–464, 519, 690
food systems 89–90, 442, 443, 450–464
forests 367–368, 371–372
gender and 274, 5.SM.5.1
human health 274, 691, 5.SM.5.1

- invasive plants 297–298
 on land 140–148
 land degradation 351, 360–363, 367–368, 369–373
 land ecosystems 84–85, 143–144
 on land use 462
 local and regional impacts of land cover change 135, 182
 migration 380–381
 oases 300–302
 peatland degradation 397–398
 pests and diseases 458
 pollinators 458–459
 poverty 259, 272–273, 279
 on rangelands 372, 454–456
 regionally distributed 143
 sensitivity of integrated response options 623–624
 short lived climate forcers 167, 169
 soil erosion 360, 361–362, 363, 624
 terrestrial biogeochemical cycles 157
 urban areas 186, 447, 752
 water resources 205, 274
- climate extreme (extreme weather or climate event)*** 16, 133, 144–148, 688
 and conflict 518, 690
 drylands 259
 financial impacts and instruments for managing 712–713
 and fire 149
 food system and security 142–143, 450–451, 451, 464, 500, 514–515, 515, 516, 5.SM.5.2
 frequency and intensity 133, 145, 147
 historical land cover change impacts 174
 and migration 516, 517, 518, 690–691
 policies responses 699–701, 714
 precipitation extremes 12, 15, 147–148, 302, 361, 7.SM.7.1
 resilience to 28, 285, 500, 513
 soil moisture and 135, 184
 spatial and temporal scales 145
 temperature extremes 12, 145–147, 174, 176, 179, 362, 516, 563
 urban areas 186–187
 vulnerability and exposure to 133, 138
see also extreme weather events
- climate feedbacks*** 138, 140
 boreal regions 182–183, 183
 BVOCs and 169, 170
 from desertification 12, 268–270, 269, 382
 from high latitude land surface changes 183–184
 from land degradation 375–377
 permafrost carbon feedbacks 183, 184
 surface albedo changes 182–184
 vegetation greening 172
 wind and solar energy installations 288
- climate finance** 34, 387, 711–713, 716
- climate governance*** 90–91, 104, 737–738, 748
- climate impact models** 513
- climate models*** 147, 173, 174–176, 174, 176, 276–278, 370
see also CMIP; Earth system models
- climate pathways** 641–644
- climate policies** 27, 68, 639, 678
 and corruption 716
 measurable indicators 725
 policy integration 103
 scenarios consistent with Paris Agreement 642
- climate-resilient pathways*** 678
- climate services*** 52, 288, 493, 513
- climate shocks** 143, 379, 513, 514–515, 515
- climate-smart agriculture (CSA)*** 474, 500, 563, 565–566, 566–567, 733, 751, 5.SM.5.5
- climate-smart forestry** 585
- climate-smart villages (CSV)** 563
- climate system*** 5, 6–7
 aerosols and 166–170
 assessing land processes in 91–92
 consequences of land-based adaptation and mitigation 47–49, 189–195
 future scenarios 92–93, 93–96, 195–201
 land and 83, 84–85, 90, 137–138
 land forcing and feedbacks 46–47, 139–140, 171–186
see also land-climate interactions
- climate targets*** 49, 195–201, 641–644
- climate variability*** 140, 278
 CO₂ land sink and 155
 fire upsurges 149
 and food security 450–451, 464
 impacts on land 140–148, 205
 impacts on livelihoods 516, 517, 518
 migration and 516–518, 517
- clouds** 166, 168, 169, 177, 377
- CMIP (Coupled Model Intercomparison Project)***
 carbon and nitrogen cycle feedbacks 157
 CMIP6 global emissions pathways 168, 170
 desertification projections 277–278
 dust emissions 167
- CO₂ equivalent emissions*** 151
- CO₂ fertilisation** 134, 155, 165, 202–203, 266, 362
 crops 451–452, 454, 463–464
 in drylands 251, 262, 267
 and fire risk 683, 684
 greening trends 144, 266, 267
 increased CO₂ removals 8, 155, 165, 202
 and nutritional quality 455, 463–464
 and rangeland productivity 455, 455, 457
- co-benefits*** 18–19, 80, 392, 609, 625
 agroforestry 383, 485, 504
 of biochar 399
 bioenergy 374, 492, 581–582, 592, 739
 carbon dioxide removal (CDR) 374, 492
 dietary change 22, 510
 disaster risk management 588
 ecosystem-based adaptation 706
 forest area expansion 99, 100
 integrated response options 627, 633
 integrated response options and SDGs 630
 integrated water management 589–590
 land management 633
 mitigation 138
 mitigation and adaptation 19–20, 21
 near-term action 33–34
 policy design 28
- re-vegetation of saline land with halophytes 283
 REDD+ and adaptation 590
 reducing deforestation and forest degradation 562
 reducing reliance on traditional biomass 375
 reducing urban sprawl 594
 responses to land degradation 381
 risk-sharing instruments 588–589
 of Sustainable Development Goals 730–731
 sustainable forest management (SFM) 351–352
 sustainable intensification 501
 sustainable land management 21, 403
 urban agriculture 505, 507
- coastal communities, risks to** 372–373, 400, 7.SM.7.2
- coastal degradation** 402, 7.SM.7.1, 7.SM.7.2
 impact of tropical cyclones 400
 saltwater intrusion 401–402
- coastal erosion** 8, 354, 356, 370, 372–373
 climate related risks 7.SM.7.1
 exceeding limits to adaptation 21
 result of sea walls 402–403
 under different SSPs 7.SM.7.1
 wetlands and 372
- coastal flooding** 402–403, 592, 692, 7.SM.7.1, 7.SM.7.2
- coastal maladaptation** 392, 402–403
- coastal wetlands**
see restoration and reduced conversion
 of coastal wetlands
- coffee crop** 372, 383, 460
- collective action*** 284, 640, 745, 748–749
- Committee on World Food Security (CFS)** 5.SM.5.5
- commodity markets** 515, 515, 516
- commodity-based systems** 465
- community-based adaptation (CBA)** 474–475, 518, 566–567
- community-based disaster risk management** 580
- community forest land** 710–711, 752
- community forestry** 385, 720
- compensatory afforestation** 710
- competition for land** 90–91, 100, 373, 610, 689
 afforestation 610
 bioenergy 42, 53–54, 62, 99
 bioenergy and BECCS 581–582, 607
 food systems 449, 502
 land-based CDR 492, 494, 687–688
 land-based response options 18–19, 24–26, 97
- compound events** 144, 146
- comprehensive risk management** 712, 721, 724
- conditional probabilistic futures** 94
- Conferences of the Parties (COPs)*** 473
- confidence*** 4*n*, 24–26, 91, 92
- conflict** 89, 150, 275, 380–381, 445, 518, 690
- Congo Basin** 353, 397
- congress weed** 298
- conservation agriculture** 100, 192, 281, 470, 471, 500–501, 566–567
 case study 561–562
 risk associated with 686
- conservation planning** 706

- consumption** 106
 - grain 605
 - contingency finance** 712–713
 - controlled traffic farming** 503
 - convection*** 139, 180, 205
 - cooperation mechanisms** 704–705
 - coping capacity*** 388
 - corporate social responsibility** 106
 - corruption** 716, 750
 - cost-benefit analysis (CBA)*** 96, 693, 694, 721
 - reforestation 396
 - sustainable land management (SLM) 381–382
 - cost-effectiveness*** 102, 693, 707, 721, 723
 - costs** 692–694, 711–713
 - of action 693, 723
 - of delayed action 102, 348, 644–645
 - of drought 290
 - of flooding 744, 7.SM.7.1
 - of inaction 102, 298, 644–645, 693
 - of integrated response options 24–26, 618, 619–623, 6.SM.6.4.1
 - of land degradation 692–693
 - of mitigation 102
 - of SLM technologies 285
 - social cost of carbon (SCC) 102, 694, 702
 - of soil erosion 682
 - of wildfires 683
 - Coupled Model Intercomparison Project***
 - see CMIP
 - cover crops** 181–182, 192, 376, 471
 - crisis management** 290, 700
 - CRISPR systems** 513
 - crop insurance** 580, 588–589, 594, 599, 603, 608, 699
 - see also risk sharing instruments
 - crop-livestock integration** 384, 485–486, 504
 - crop models** 380, 453–454, 453
 - crop production**
 - adaptation options 470–471
 - crop suitability 454
 - economic mitigation potential 486
 - fruit and vegetables 454
 - GHG mitigation 483, 486
 - global trends 444
 - impacts of climate change 8, 380, 451–454, 458–459, 5.SM.5.2
 - improved crop management 493
 - land area suitable for 454
 - projected impacts 453–454
 - sustainable intensification 481–482
 - technical mitigation potential 483
 - see also crops; rice cultivation
 - crop productivity** 273, 366, 373, 518
 - assessing climate change impacts 380
 - changes for 1.5°C and 2.0°C 279, 454, 680–681
 - saline lands 283
 - temperature and crop suitability 300–301
 - see also crop yields
 - crop yields** 362–363, 379–380, 500
 - closing yield gaps 466, 501, 603
 - global trends 444, 451–452
 - impact of climate change 8, 5.SM.5.2
 - impact of extreme weather and climate 143, 464, 690
 - increasing 605, 606, 607
 - low altitudes 680–681, 681
 - projected 453
 - risks from climate change 680–681, 681, 685, 7.SM.7.1
 - under different SSPs 7.SM.7.1
 - warming temperatures and 5.SM.5.2
 - croplands** 22, 79, 561–562, 633
 - acidification 355
 - albedo 181–182, 181
 - biochar biomass production 605
 - bioenergy cropland 31–32, 62, 194, 196, 199, 642–644, 646
 - current land use 79, 85–86, 85
 - dryland areas 254, 256
 - expansion 562, 595, 602, 603, 604
 - GHG emissions 476, 477
 - N₂O emissions 134, 162, 181–182, 476, 477
 - GHG mitigation 22, 483
 - global trends 86, 87
 - impact of urban expansion 603
 - integrated crop-soil-water management 280–281
 - land tenure 287
 - mitigation potential 189
 - nitrogen addition to soils 134, 162, 163
 - overlapping land challenges 560, 561, 561, 633
 - projected land use change 30–32, 461, 462
 - reduction in 197
 - regional and local temperature change 194
 - smallholders 751
 - soil carbon sequestration 192, 483
 - soil erosion 293, 294, 596
 - soil organic carbon 393–395
 - see also improved cropland management; reduced grassland conversion to cropland
 - crops** 79, 84–85
 - agronomic practices 382–383
 - bioenergy 97, 193–194, 373–374, 492, 576, 646
 - biofuel 193–194, 283, 739
 - cover crops 181–182, 192, 376, 471
 - diversification 468, 469, 589
 - genetics 513
 - indigenous 469
 - loss 606, 606
 - nutrient quality 463
 - oasis areas 300–301
 - perennial 194, 383, 392, 393–395, 485
 - perennial grains 392, 393–395
 - pests and diseases 458
 - pollinators 458–459
 - reduced nutritional value 7.SM.7.2
 - suitability 372, 454
 - viability under climate change 301
 - see also local seeds
 - cross-level integration** 738
 - cross-sectorial integration** 738
 - cultural policy instruments** 106
 - cultural values** 470
 - cultured meat (CM)** 199, 487
 - customary norms** 106, 720
 - cyclones** see tropical cyclones
 - Czech Republic** 453
- ## D
- dairy systems** 483
 - dams and dam-building** 734, 735
 - data sources** 91–92
 - date palms** 300–301
 - decarbonisation*** 97, 675
 - decentralised governance** 287
 - decision making** 68, 70, 638–639, 678, 719–725, 726
 - adaptive management 723–725, 724
 - cost-benefit analysis 96
 - economic approaches 721
 - effectiveness 28–29
 - FAQs 755–756
 - formal/informal 720
 - futures analysis 93, 96
 - in global models 96
 - human-environment interactions 360
 - indigenous and local knowledge (ILK) 747–748
 - knowledge gaps 755
 - participation 754
 - performance indicators 725
 - precautionary approach 96
 - problem structuring 720–721
 - response to key challenges 103
 - synergies and trade-offs 725, 726, 730–734
 - tools 721–723, 722, 734
 - under uncertainty 96, 693, 719, 721–723, 722
 - deforestation*** 79, 368, 562
 - and agricultural expansion 481
 - agricultural expansion 481–482
 - albedo impacts 377
 - boreal regions 177, 179
 - BVOCs emissions 170
 - CO₂ emissions 8–9, 153, 155, 176–177, 177, 476
 - community-managed forests 385
 - definition 155
 - drivers 367
 - emissions estimates 45, 385–386
 - emissions reduction 388
 - and fire 149
 - historical land cover change impacts 170, 174
 - impact on climate 12, 176–180
 - imported deforestation 707, 709
 - and land tenure 749, 752
 - mangroves 402
 - mitigation potential 189–191
 - and net forest area increase 98
 - non-local and downwind rainfall effects 185–186, 185
 - physical effects 377
 - REDD+ 385–386, 709–710
 - reducing/halting 100, 385–386, 388, 481–482, 562
 - seasonal impacts 178, 179, 179–180
 - simultaneous cooling and warming response 176–177

- soil N₂O emissions 162
- and spread of malaria 691
- temperate regions 177, 178–179
- tropical regions 177–178, 177, 385–386, 562
 - see also reduced deforestation
 - and forest degradation
- delayed action** 34, 67, 102, 348, 554, 644–645
- deliberative governance*** 745
- deltas** 372–373, 401–402
- demand management response options**
 - 101–102, 195, 577, 610
 - adaptation potential 493, 593, 593
 - delayed action 645
 - feasibility 618, 622, 6.SM.6.4.1
 - impact on desertification 598, 598
 - impact on food security 607, 607
 - impact on land degradation 602, 602
 - impact on NCP 629, 6.SM.6.4.3
 - impact on SDGs 632, 6.SM.6.4.3
 - mitigation potential 190, 191, 195, 493, 587, 588
 - policy instruments 698, 726
 - potential across land challenges 615
 - sensitivity to climate change impacts 624
 - uncertainties in potentials 5.SM.5.3
- demand-side adaptation** 439, 472–473
- demand-side management** 101–102, 195, 493, 698
- demand-side mitigation options** 487–491
- dense settlements** 560, 561, 561, 563, 633
 - see also urban areas
- desertification*** 5, 6–7, 7, 50–52, 89, 249–343, 558, 689
 - adaptation limits 20, 252–253, 291
 - addressing 19–20, 255–256, 279–305
 - barriers to 292
 - costs of 285
 - potential for 24–26, 595–599, 609–610, 609, 611–617
 - afforestation/reforestation programmes 294–296, 297
 - anthropogenic drivers 251, 259–260, 264, 268
 - assessing 260–265
 - attribution methods 265–268
 - biodiversity and 263, 271–272, 278–279
 - case studies 266–268, 292–305
 - challenge 559, 560, 561, 564, 565
 - climate related risks 7.SM.7.1, 7.SM.7.3
 - defined 4*n*, 107, 254
 - desertification syndrome vs. drylands development 260
 - detection and assessment methods 255, 260–262
 - difference from land degradation 107, 254
 - drivers 251, 258–260, 264, 268, 382
 - ecosystem services and 270–271, 278–279
 - FAQs 107, 306, 646
 - feedbacks to climate 12, 268–270, 269, 382
 - financing mechanisms 712
 - fire and 149, 259, 597, 597
 - future projections 276–279
 - future scenarios 564, 565, 634, 635
 - global scale 255, 260–262, 599
 - hotspots 292
 - impact of climate change 7–8, 258–260
 - impact of integrated response options 19–20, 595–599, 611–617
 - impact of risk management 598–599, 599, 617
 - impacts of 270–276, 278–279
 - indicators of 255
 - knowledge gaps 305–306
 - local case studies 266–268
 - location-specific trends 263–265
 - maladaptation 291–292
 - migration and 295
 - near-term action 33–34
 - on-the-ground actions 279–283, 280
 - policy responses 285–289, 290–291, 696, 705–706
 - previous IPCC and related reports 256
 - processes 258–259
 - regional scale 263–265, 277
 - research and development investment 287–288
 - risks from climate change 681, 682–683
 - under different SSPs 684, 685, 7.SM.7.1, 7.SM.7.3
 - SLM practices 255–256, 279–283
 - adoption of 283–284, 285–288
 - socio-economic impacts of 272–276, 279
 - socio-economic response 283–285, 288–289
 - soil erosion and 292–294, 596
 - technologies 285, 287–288
 - urban response options 188
- detection and attribution*** 91, 5.SM.5.2
- developing countries** 372, 390, 512, 618, 701
 - agriculture 384, 697, 699
 - citizen engagement 754
 - deforestation 368, 369, 385
 - dryland populations 257–258
 - early warning systems 91, 253, 290
 - emissions 186, 704, 709
 - energy sources 288, 375, 494
 - finance 387, 701, 711–712, 713
 - floods 744
 - food loss and waste 100–101, 440, 490, 577
 - food security 465, 468, 472, 697
 - food systems 593, 604, 605
 - GHGI reporting 164
 - land tenure 749–750, 751–752
 - large-scale land acquisitions 91, 750
 - livelihoods 378–379, 608
 - NDCs 199, 704
 - poverty 53, 257–258, 290, 378–379
 - risk sharing 699
 - social protection systems 699
 - technology transfer 68, 704
 - urbanisation 186, 603
 - vulnerability 449, 452, 573
 - women 285, 718
 - see also REDD+
- development pathways*** 16, 756
- DGVM**
 - see Dynamic Global Vegetation Models (DGVMs)
- diet*** 79–80, 86, 101, 5.SM.5.4
 - addressing climate change 22, 519
 - changing see dietary change
 - cultured meat (CM) 487
 - dietary diversity 468, 469
 - dietary patterns 101
 - GHG emissions for different diets 479–480
 - and health 497–499, 498
 - indigenous communities 106
 - insect-based diets 490
 - local produce 491
 - low GHG emission diets 497–499
 - mitigation potential 195, 487–489, 488
 - near-term action 34
 - and poverty 442
 - reducing meat consumption 489, 498–499, 5.SM.5.3, 5.SM.5.4
 - rural diets 605
 - sensitivity to climate change impacts 624
 - sustainable 497–499
 - traditional 469
 - urban diets 505
- dietary change** 101, 195, 196, 469, 490, 497–499, 567, 577
 - adaptation potential 593, 593
 - co-benefits 510
 - combined with bioenergy and BECCS 637
 - feasibility 622, 6.SM.6.4.1
 - impact on desertification 598, 598
 - impact on food security 607, 607
 - impact on land degradation 602, 602
 - impact on NCP 629, 6.SM.6.4.3
 - impact on SDGs 632, 6.SM.6.4.3
 - interlinkages 636
 - mitigation potential 487–489, 488, 587, 588
 - policy instruments 726
 - potential across land challenges 609, 610, 615
 - sensitivity to climate change impacts 624
 - socio-cultural barriers 618
 - technical mitigation potential uncertainties 5.SM.5.3
- direct aerosol effect** 169, 170, 192
- disaster risk management (DRM)** 567, 580, 744–745
 - adaptation potential 594, 594
 - feasibility 623, 6.SM.6.4.1
 - impact on desertification 598, 599
 - impact on food security 608, 609
 - impact on land degradation 603, 603
 - impact on NCP 629, 6.SM.6.4.3
 - impact on SDGs 632, 6.SM.6.4.3
 - mitigation potential 588
 - policy instruments 726
 - potential across land challenges 610, 617
 - sensitivity to climate change impacts 624
- disaster risk reduction (DRR)** 33, 396, 467, 474–475, 744
- discount rates*** 694
- diseases** see human health; pests and diseases
- disruptive technology** 511
- diurnal temperature** 178, 179, 180, 186–187
- diversification**
 - agricultural production systems 504
 - crop diversification 468, 469, 589
 - dietary diversity 468
 - economic 285, 288–289
 - energy supply 20

- food system 22, 468–470, 469
 intensively managed systems 504
 livestock production systems 589
 see also agricultural diversification;
 livelihood diversification
- downwind effects** 135, 184–186, 185
- drainage*** 89, 355
 peatlands 160, 397–398
 wetlands 193
- drought*** 7, 82–83, 145–147, 276
 adaptation measures 686
 climate related risks 7.SM.7.1
 conflict and 516, 518
 costs 290
 defined 254
 and desertification 265
 drivers of 258–259, 266
 Dust Bowl-type 514–515
 early warning systems (EWS) 475, 594, 598, 608
 fires 149
 food security and 450, 451, 464, 516, 690
 frequency and intensity 15
 impact on food security 5.SM.5.2
 impact on land 146–147
 inter-annual variability 145–146
 livestock and 457–458
 maladaptation 734
 migration and 276, 285, 518
 policy responses to 290–291, 714
 projections 144, 277–278
 risks and risk management 290–291,
 682–683, 700
 soil moisture and 184
 trends 145–146
 vegetation response 202
- drought risk mitigation** 290–291
- dryland areas** 5, 6–7, 7, 16, 89
 adaptive capacity 16, 753
 addressing desertification 279–284, 286–288
 agriculture 16, 257, 259
 biodiversity 271–272, 278–279, 735
 classification 254, 255
 climate-driven changes in aridity 142
 delineating in increasing CO₂ environment 254
 drivers of vegetation change 265–268, 267
 economic diversification 285, 288–289
 ecosystem services 270–271
 expansion 278
 food demand 259
 food security 8
 future projections 277–279
 geographic distribution 254–255, 254, 255
 impacts of climate change 142, 278–279
 indigenous and local knowledge (ILK) 284, 747
 land degradation 262
 land tenure 753
 land use/cover 254–255, 256, 257
 livelihoods 257–258, 304
 near-term actions 33–34
 poverty 257, 259, 260
 precipitation 258, 262, 265, 278
 renewable energy 735
 soil erosion 258, 259, 278
- tipping points 645
 vulnerability and risk of desertification
 277–278, 645
 water scarcity 681, 682–683, 684, 685, 7.SM.7.1
- dryland populations** 16, 89, 255–256, 257
 anthropogenic drivers of desertification
 259–260
 vulnerability and resilience 256–258
- dust** 166–167, 268–269, 269, 377, 683
- dust mass path (DMP)** 167
- dust storms** 7, 268, 271, 275, 682
 combating 20, 283, 294–295
 health effects 274
 impacts of climate change 277
- dynamic adaptation pathways** 721–722
- Dynamic Global Vegetation Models (DGVMs)**
 153, 154, 155, 156–157, 156, 163
 temperature response to land cover change
 173, 175
- E**
- early warning systems (EWS)*** 91–92, 102, 475,
 598, 700
 effectiveness 594
 food security related 91–92, 594, 608
 near-term actions 33
 sand and dust storms 288
- Earth system models (ESMs)*** 95, 140, 163
 soil and plant processes 201–204
 sources of uncertainty 144, 156–157, 201–202
 temperature response to land cover change 175
 underestimating emissions 168
- East Asia** 168, 176, 395–396
 see also China
- ecological cascades*** 251
- ecological fiscal transfer (EFT)** 711
- economic barriers** 618, 619–623, 715, 6.SM.6.4.1
- economic decision making approaches** 721
- economic diversification** 285, 288–289
- economic growth** 644–645
- economic health costs** 510
- economic mitigation potential** 483, 486, 489
- economic policy instruments** 105–106
- economics** 692–694
- ecosystem-based adaptation (EbA)** 19, 282, 381,
 468, 470, 566–567, 706–707
- ecosystem services (ES)*** 79, 625–626
 aquatic 733–734
 cultural 353
 drylands 270–271
 forest area expansion 99
 green energy and 735
 human-environment interactions 360
 impact of afforestation and reforestation 97
 impact of bioenergy crop deployment 97,
 687–688, 687
 impact of climate change 404
 impact of invasive plant species 297–300
 market-based policy instruments 105
 near-term actions and 33–34
 non-material 81
- PES schemes 105, 287, 706–707, 733
 risk to 691
 SLM practices and 306
 synergies and trade-offs 730, 731, 731, 735
 valuing 5, 79, 81, 350, 692–694
- ecosystems***
 changes in distribution 172, 182
 climate-driven changes 143–144, 355
 climate-related risks 680–688, 688–689
 health and resilience 592
 impact on climate 84
 impacts of bioenergy crop deployment
 687–688, 687
 impacts of climate change 7–8, 84–85, 270–272
 impacts of desertification 270–272
 impacts of land degradation 88–89, 354–356
 implications of forest area increase 98–99
 land ecosystems 79, 84–85
 land management response options 97
 managed/unmanaged 139–140, 172, 191, 203,
 270–272, 356
 management 747
 models 95, 266
 plant composition changes 355
 resilience 146, 147, 265
 restoration 707
 risk of delayed action 34
 vulnerability to irreversibility 645
- EDGAR**
 see Emissions Database for Global
 Atmospheric Research
- education** 286, 512
- Egypt** 301, 302
- El Niño-Southern Oscillation (ENSO)*** 146, 149,
 305, 361, 397, 450
- elemental carbon (EC)** 167–168
- elite capture** 716
- emergent risks** 678, 679
- emissions**
 aerosols 166, 168–169
 emissions pricing 702, 703
 estimating 9, 152–155, 154, 156, 163–164
 fugitive emissions 159
 knowledge gaps 513
 land sector net emissions 8–11, 10–11
 net negative 198, 580
 net reductions needed to limit global warming to
 2°C or 1.5°C 197–199
 peatland 159–160
 policies 701–705
 regional differences 155, 156
 short-lived climate forcers (SLCF) 166–167, 168,
 169, 170
 soil carbon and microbial processes 201
 urban areas 186
 see also AFOLU; anthropogenic emissions;
 greenhouse gas emissions
- Emissions Database for Global Atmospheric
 Research (EDGAR)** 160, 160, 161
- Emissions Trading System (ETS)** 702, 703, 753
- enabling conditions*** 27–29, 103–106, 558,
 638–640
 coordinated action 554, 640

- food security related adaptation 467
- food system policies 27–28, 440, 507–512
- land management responses 633
- policy effectiveness 713–714
- for REDD+ 385
- end-use/market integration** 738
- energy access** 20, 709, 741
- energy demand** 731
- energy infrastructure** 275
- energy services** 740
- energy use**
 - see improved energy use in food systems
- enhanced urban food systems** 567, 578
 - adaptation potential 593
 - feasibility 622, 6.SM.6.4.1
 - impact on desertification 598
 - impact on food security 608, 608
 - impact on land degradation 602
 - impact on NCP 629, 6.SM.6.4.3
 - impact on SDGs 632, 6.SM.6.4.3
 - policy instruments 726
 - potential across land challenges 616
 - sensitivity to climate change impacts 624
- Enhanced Vegetation Index (EVI)** 363
- enhanced weathering* of minerals** 194, 567, 575
 - adaptation potential 592
 - feasibility 621, 6.SM.6.4.1
 - impact on desertification 597
 - impact on food security 607, 607
 - impact on land degradation 601, 602
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 587, 587
 - potential across land challenges 610, 615
 - sensitivity to climate change impacts 624
- ensemble (models)*** 150, 262, 267, 278
- enteric contamination** 462–463
- enteric fermentation** 160, 189, 477, 484
- environmental barriers** 619–623, 6.SM.6.4.1
- environmental risk** 275–276
- equality***
 - in decision making 754
 - enhancing gender equality 70
 - impacts on gender equality 274
 - inequality as barrier to climate action 716
 - see also gender equality; inequality
- equity*** 42–43, 68, 717–719
 - climate change and food system 58, 446–447, 447–448
 - in decision making 638–639
 - see also gender equity
- erosion** 258, 259, 263, 264, 265
 - gully erosion 302, 303, 304, 359, 7.SM.7.1
 - and precipitation 361–362, 370–371, 682
 - see also coastal erosion; soil erosion; water erosion; wind erosion
- ES** see ecosystem services
- Ethiopia**
 - drought 450, 451
 - invasive plants 298
 - Tigray region croplands 561–562
 - work-for-insurance programmes 699
- Eucalyptus camaldulensis** 299
- Eurasia** 172–173, 174
- Europe**
 - agricultural emissions 159
 - black carbon emissions 168
 - crop production and climate change 453
 - cropland albedo 181
 - desertification 264
 - dryland areas 255, 264
 - dryland population 257
 - food safety 463
 - forestation 179
- European Union (EU)**
 - emissions 753
 - mitigation and adaptation 737–738
 - Renewable Energy Directive (EU-RED) 709
- eutrophication** 358
- evaporation*** 362
- evapotranspiration*** 98, 137, 177, 178
 - and soil moisture content 362
 - tropical regions 183
- EVI (Enhanced Vegetation Index)** 363
- expanded policies** 508–510, 509, 5.SM.5.5
- expert judgement** 680, 722, 7.SM.7.1
- explicit nitrogen stress** 453, 454
- exploratory scenario analysis** 93–94
- exposure*** 680, 683, 684–686, 688, 688–689, 745
 - communities and infrastructure 691, 692
 - in different SSPs 684–686, 730
 - to fire 7.SM.7.1
 - to flood 7.SM.7.1
- extension** 695, 697, 719
- externalities** 694
- extreme weather events*** 85, 144
 - adaptive governance and 742–743
 - and crop yields 102, 143, 459–460, 516, 681–682
 - early warning systems 475
 - food systems and security 459–460, 462, 465
 - food prices and markets 514–515, 515, 516
 - food supply stability 15, 147–148, 464, 514–515, 682
 - infrastructure vulnerability 692
 - insurance 594, 699–700, 712
 - and land tenure 751
 - and poverty 259, 272, 306
 - and smallholders 459–460
 - see also climate extreme
- F**
- Fakara region, Niger** 263
- famine early warning systems** 594, 608, 700
- FAOSTAT emissions data** 151, 153, 154, 156, 157, 160, 160, 161, 164, 200
- FAQ** see frequently asked questions
- farmer-led innovations** 284
- feasibility*** 618, 619–623, 6.SM.6.4.1
- feedstock** 19, 605, 610
- fertiliser** 6–7, 79, 86, 500
 - CO₂ fertilisation effect 202–203, 262, 362
 - N₂O fluxes 160, 161, 162, 163
 - nitrogen fertilisation 134, 159, 203
 - overfertilisation 357
 - synthetic nitrogen 160, 162, 476, 477
- FIES** see Food Insecurity Experience Scale
- financial policy instruments** 105–106, 474, 698, 710–711
 - risk management 467–468, 700–701
- financing mechanisms** 34, 387, 475, 711–713
- fire** 133, 148–150
 - area burnt 148–149, 150, 156, 168, 683, 7.SM.7.1
 - biomass burning 162, 168, 169
 - climate change and fire regimes 149–150, 683–684
 - damage 606, 681, 683–684
 - desertification and 149, 259
 - emissions 149, 162, 168, 169, 270, 376, 397, 573, 7.SM.7.1
 - fire weather season length 14, 45, 149–150, 7.SM.7.1
 - forests 149, 372, 700
 - frequency 382, 7.SM.7.1
 - future projections 149–150
 - impact of invasive plant species 297, 299
 - increased burning 359
 - land degradation 149, 376
 - management see fire management
 - peatlands 149, 397, 398
 - rangeland management 281–282
 - regimes 149–150, 376, 683–684, 700
 - risk management 700
 - risks 149–150, 593, 681, 683–684, 7.SM.7.1
 - societal impacts 397, 683
- fire management** 280, 281–282, 567, 573
 - adaptation potential 591, 592
 - feasibility 627, 6.SM.6.4.1
 - forests 700
 - impact on desertification 597, 597
 - impact on food security 606, 606
 - impact on land degradation 601, 601
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - interlinkages 636–637
 - mitigation potential 586, 587
 - policy instruments 726
 - potential across land challenges 609, 614
 - potential deployment area 633, 633
 - sensitivity to climate change impacts 624
- fisheries** 471, 478, 5.SM.5.2
- flexitarian diet** 488, 489, 498, 510
- floodplains** 752
- floods*** 147–148, 358
 - Bangkok flood 472
 - coastal flooding 402–403, 592, 692, 7.SM.7.1, 7.SM.7.2
 - costs 744, 7.SM.7.1
 - fisheries management 471
 - food safety and human health 462–463
 - governance indicators 753
 - impact on food security 743–745, 5.SM.5.2
 - impact of peatlands 592
 - increased likelihood 371
 - insurance 701, 744
 - land degradation and GHGs 377
 - Limpopo River basin 305

- policies 714, 744
 - recurring episodes 355
 - risk management 700–701
 - risks 685
 - under different SSPs 7.SM.7.1
 - food access** 15, 443, 513, 514, 697–698
 - gender and 447
 - impact of climate change 443, 460–462, 461, 690
 - impact of climate drivers 5.SM.5.2
 - and poverty 446
 - risks to 685, 7.SM.7.1
 - under different SSPs 7.SM.7.1
 - Food and Agriculture Organization of the UN (FAO)** 83, 473–474
 - food aid** 607
 - food availability** 443, 472, 513–514
 - crop production 451–454
 - gender and 447
 - global trends 444, 445
 - impact of climate change 15, 443, 450, 451–460
 - impact of climate drivers 450, 5.SM.5.2
 - livestock production 454–458, 455
 - policies 697
 - risks to 685, 7.SM.7.1
 - seasonal supply shocks 467
 - under different SSPs 7.SM.7.1
 - food demand** 6, 82–83, 259
 - projected increase 88, 502–505
 - food-energy-water nexus** 466, 514
 - food insecurity** 508
 - assessing 442, 446
 - defining 442
 - future scenarios 564, 565
 - migration and 516–518, 517
 - spatial distribution 446
 - status and trends 445–446, 445
 - see also food security*
 - Food Insecurity Experience Scale (FIES)** 442, 446
 - food loss and waste*** 5, 100–102, 195, 473, 490–491
 - demand-side 101–102, 195
 - education 512
 - GHG emissions 476, 490–491
 - policy response 510
 - reduction 22, 498, 507, 512
 - reduction and use of 485–486
 - SDGs and 507
 - supply-side 100–101
 - see also reduced food waste (consumer or retailer); reduced post-harvest losses
 - food prices** 15, 510, 605, 7.SM.7.1
 - controls 607
 - impact of climate change 460–462, 461, 685–686
 - impact of climate drivers 5.SM.5.2
 - impact of large-based CDR 492, 494
 - shocks 508
 - spikes 514–515, 515, 516, 593, 682
 - stability 607
 - taxes 698
 - food processing** 478–479
 - see also improved food processing and retailing
 - food production** 606, 697
 - and bioenergy deployment 7.SM.7.1
 - building resilience into 466
 - climate drivers relevant to 450–451
 - risks to in dryland areas 684, 685
 - transformative change 465–466
 - see also increased food productivity
 - food quality** 463–464
 - food safety** 462–463, 472
 - food security*** 20, 56–59, 79–80, 81, 89–90, 437–550, 441, 443, 558
 - adaptation 443, 472, 475
 - adaptation options 467
 - assessing 442, 446
 - case studies 561, 563
 - challenge 88, 559, 560, 561
 - climate drivers relevant to 450–451, 5.SM.5.2
 - climate related risks 7.SM.7.1, 7.SM.7.3
 - co-benefits with agroforestry GHG mitigation 485
 - community-based adaptation (CBA) 474–475
 - conflict and 518
 - defined 4n, 89, 442
 - detection and attribution methods 5.SM.5.2
 - dietary diversity 468
 - early warning systems 475
 - ecosystem-based adaptation (EbA) 468, 470
 - enabling conditions for adaptation 467
 - equity and 446–447, 447–448
 - extreme climate events 464–465
 - FAQs 646
 - financial resources 475
 - floods and 743–745
 - food aid 464
 - food loss and waste 490–491, 507
 - food prices 446, 447, 460–462, 461, 494–497, 495
 - spikes 515–516, 515, 516
 - food safety and quality 462–464
 - four pillars
 - see food access; food availability; food stability; food utilisation
 - framing and context 441–450
 - future challenges 514–518
 - future scenarios 450, 634, 635
 - gendered approach to climate change impacts 446, 447–448, 456, 5.SM.5.1
 - global initiatives 473–474
 - governance 5.SM.5.5
 - health and 447, 450, 462–463
 - hidden hunger 442, 445–446
 - Hindu-Kush Himalayan Region 469
 - hunger, risk of 460–462, 461, 495, 685–686, 7.SM.7.1
 - impact of climate change 7–8, 15, 142–143, 442, 443, 450–464, 519, 690
 - impact of climate drivers 5.SM.5.2
 - impact of desertification 272, 273
 - impact of integrated response options 24–26, 603–608, 609, 610, 611–617
 - impact of land-based CDR and bioenergy 492, 494, 607, 607, 615, 687–688
 - impact of land degradation 379–380
 - impact of land grabbing 91, 750
 - impact of land-use change 461, 462
 - impact of risk management options 608, 609
 - incorporating ILK in decision making 747–748
 - incremental adaptation 467
 - integrated approaches 492
 - knowledge gaps and key research areas 513–514
 - links to SDGs 506, 507
 - migration and 516–518, 517
 - mitigation 443
 - mobilising knowledge 512
 - near-term action 33–34
 - as outcome of food system 442
 - policies 474, 696–698, 696
 - pollinators, role of 458–459
 - potential for addressing 24–26, 603–608, 609, 610, 611–617
 - prevalence of undernourishment (PoU) 464
 - protein availability 463
 - risk management 467–468, 475, 608
 - risks from bioenergy and BECCS 687–688
 - risks from climate change 680–682, 681
 - under different SSPs 685–686, 685, 7.SM.7.1, 7.SM.7.3
 - spatial distribution of food insecurity 446
 - status and trends 445–446, 445
 - sustainable intensification 501–502, 507
 - synergies with adaptation and mitigation 448
 - synergies and trade-offs 29, 492, 494, 730, 731
 - temporal scales 738
 - trade policies 508
 - and traditional biomass use 741
 - transformational change in food systems 466–467, 467
 - urban areas 188, 449, 505, 507, 607
 - see also food insecurity
- food sovereignty** 508, 608
- food stability** 443, 479, 513, 514, 593, 607
 - gender and 447
 - impact of climate change 443, 464, 682, 690
 - impact of climate drivers 5.SM.5.2
 - risks to 7.SM.7.1
- food supply** 5, 697
 - instability 681, 682
 - risks to 7.SM.7.1
 - stability 15, 685
- food system*** 15–16, 56–59, 60, 89–90, 90, 443
 - adaptation challenges 464–465
 - adaptation options 21–22, 443, 449, 464–475, 513–514
 - agroecology 468–470, 469
 - capacity building and education 512
 - climate change response options 448–449
 - climate drivers important to 450–451
 - culture and beliefs 470
 - defined 8n
 - demand-side adaptation 472–473, 513–514
 - demand-side mitigation 487–491, 513–514
 - detection and attribution methods of climate change impacts 5.SM.5.2
 - dietary preferences and consumer choice 489
 - diversification 22, 468–470, 469
 - economic health costs 510
 - enabling conditions 27–28, 440, 507–512

- expanded policies 508–510, 509, 5.SM.5.5
- food security as an outcome of 442
- food supply and required food 444
- future projections 479–480, 5.SM.5.2
- gender and equity 58, 446–447, 447–448
- GHG emissions 8, 10–11, 11, 475–480, 476, 477, 478, 513, 519
- global system 8, 10–11, 11
- global trends 444, 445
- governance 507, 5.SM.5.5
- impact on climate change 475–480
- impact of climate change 450–464
- impact of climate extremes 465, 514–515, 515, 516
- indigenous food systems 469
- institutional measures 473–475, 512
- integrated agricultural systems 499–502, 504
- interlinkages 441
- investment and insurance 511
- Just Transitions to sustainability 511
- knowledge gaps 511, 513–514
- land competition 449, 502
- local system 608
- markets and trade 80, 472, 508, 511
- mitigation 21–22, 443, 449, 480–491, 513
- mitigation potential 449
- mobilising knowledge 512
- Paris Agreement and 449
- policy responses 27–28, 474, 507–510, 509
 - acceptable to the public 490, 510, 698
 - agriculture and trade 508
 - health related 510
- previous reports 448–449, 450
- processing 472, 508
- production
 - see crop production; livestock production systems
- projected emissions 480
- response options related to 21–22, 492, 493
- risk management 467–468
- scenario analysis 93–94
- in SSPs 13
- supply chains 491, 513
- supply-side adaptation 470–472, 513–514
- supply-side mitigation 480–487, 484, 513–514
- sustainable 465–466, 502–505
- synergies and trade-offs 492, 493, 494, 513–514, 733–734, 5.SM.5.5
- transformational change 449
- transport and storage 471–472
- urban areas 505, 507
- value chain management 100–102
- vulnerability to climate change 680–682, 681
 - see also enhanced urban food systems
- food utilisation** 443, 513–514, 7.SM.7.2
 - gender and 447
 - impact of climate change 443, 462–464
 - impact of climate drivers 5.SM.5.2
 - risks to 7.SM.7.1
- forest carbon density** 395, 396
- forest carbon sink** 21, 156, 180, 386
- forest carbon stocks** 21, 351, 352, 367, 368–369, 385–387
- forest certification schemes** 585, 602
- forest conservation instruments** 709–711
- forest degradation** 367–369
 - albedo impacts 377
 - charcoal production 375
 - defined 350
 - emissions 385–386
 - local land users 353
 - reducing 189–191, 385–386, 388, 562
 - traditional biomass use 740–741
 - see also reduced deforestation and forest degradation
- forest dieback** 371–372, 683, 688
- forest governance** 715–716
- forest management** 368–369, 567, 571
 - adaptation potential 590, 590
 - feasibility 620, 6.SM.6.4.1
 - illegal logging 716
 - impact on desertification 595–596, 596
 - impact on food security 604, 605
 - impact on land degradation 600, 600
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 189–192, 584–585, 585
 - policy instruments 726
 - potential across land challenges 610, 612
 - potential deployment area 633
 - rice cultivation 384
 - water balance 371
- forest mitigation** 715–716, 733
- forest productivity** 351–352, 352, 353
 - climate related risks 7.SM.7.1
- forest response options** 100, 189–192, 571–572
 - adaptation potential 590, 590, 612
 - feasibility 620, 6.SM.6.4.1
 - impact on desertification 595–596, 596, 612
 - impact on food security 604–605, 605, 612
 - impact on land degradation 600, 600, 612
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 584–585, 585, 612
 - policy instruments 726
 - potential across land challenges 610, 612
 - sensitivity to climate change impacts 623–624
 - synergies and trade-offs 733
- forestation**
 - climate impacts 176–180
 - combined forestation and irrigation 185, 185
 - seasonal impacts 178–179, 179–180
 - see also afforestation; reforestation
- forests*** 6, 85
 - adaptive capacity 103
 - albedo 191–192
 - biodiversity 98–99, 352
 - biogeochemical and biophysical processes 98
 - BVOC emissions 169, 192
 - carbon stocks 351, 352
 - certification schemes 352–353, 707–709, 708
 - community-managed forests 385
 - cover change and climate feedbacks 12, 176–180, 185
 - current land use 85–86, 85
 - dryland areas 254, 256
- effect on temperature variation 174
- emissions contributions 368
- fire 149, 372, 700
- fire management 700
- food from 605
- global change and mitigation scenarios 197
- global trends in tree-cover 86–88, 87
- growth rates 386
- harvest 386–387
- hydrological cycle 371
- impacts of climate change 367–368, 371–372
- impacts of flooding 148
- impacts of heat extremes and drought 146
- land degradation 89
- land management response options 97
- land productivity trends 366, 367
- land sink and 156
- land tenure 749, 752
- large-scale conversion non-forest to forest land 98–100
- managed forest for bioenergy 194
- managed forest CO₂ emissions 9, 155
- net area increase 98
- plant water transport 202
- productive capacity 368–369
- projected land use change 30–32, 461, 642
- regrowth 352, 353
- restoration 98, 191, 733
- secondary organic aerosols (SOA) 169
- sequestration potential 99
- water balance 98
- wildfires 372
 - see also reforestation and forest restoration; sustainable forest management
- formal institutions** 720, 747
- fossil fuels***
 - emissions 153, 153, 168
 - reducing use of 486
 - subsidies 701
- framing and context** 40–43, 77–129
 - dealing with uncertainties 91–93, 96
 - enabling response to key challenges 103–106
 - interdisciplinary nature of SRCCL 106
 - key challenges related to land use change 88–96
 - of land and climate issues 745–746
 - objectives and scope 81–84
 - previous reports 83
 - response options 96–103, 97
- frequently asked questions (FAQs)**
 - 1.1 What are the approaches to study the interactions between land and climate? 107
 - 1.2 How region-specific are the impacts of different land-based adaptation and mitigation options? 107
 - 1.3 What is the difference between desertification and land degradation and where are they happening? 107
 - 2.1 How does climate change affect land use and land cover? 205
 - 2.2 How do the land and land use contribute to climate change? 205

- 2.3 How does climate change affect water resources? 205
- 3.1 How does climate change affect desertification? 306
- 3.2 How can climate change induced desertification be avoided, reduced or reversed? 306
- 3.3 How do sustainable land management practices affect ecosystem services and biodiversity? 306
- 4.1 How do climate change and land degradation interact with land use? 404
- 4.2 How does climate change affect land-related ecosystem services and biodiversity? 404
- 5.1 How does climate change affect food security? 519
- 5.2 How can changing diets help address climate change? 519
- 6.1 What types of land-based options can help mitigate and adapt to climate change? 646
- 6.2 Which land-based mitigation measures could affect desertification land degradation or food security? 646
- 6.2 What is the role of bioenergy in climate change mitigation, and what are its challenges? 646
- 7.1 How can ILK inform land-based mitigation and adaptation options? 755
- 7.2 What are the main barriers to and opportunities for land-based responses to climate change? 756
- futures analysis** 80, 93–96
- G**
- GCM**
see general circulation models;
global climate models
- GDEWS (Global Drought Early Warning System)** 598
- GEF (Global Environmental Facility)** 387, 388, 390
- gender equality** 274, 631–632, 717
land use and land management 286
and response option implementation 639
women's empowerment 29, 70, 286, 448, 488, 639, 718–719
- gender equity*** 80, 104–105
conservation agriculture 501
dryland areas 257–258
food security and climate change 446, 447–448
women's empowerment policies 286
- gender inclusive approaches** 446, 447–448, 456, 717–719, 5.SM.5.1
- gender inequality** 353, 639, 716, 717–718
- general circulation models (GCMs)** 147, 370
- geophysical barriers** 619–623, 6.SM.6.4.1
- GFED4s (Global Fire Emissions Database v.4)** 148, 149
- GFGP (Grain for Green Program)** 396
- GHGI** see greenhouse gas inventories
- gilir balik cultivation** 384
- glaciers*** 294
- GLASOD (Global Assessment of Human-induced Soil Degradation)** 261
- global climate models (GCMs)*** 173, 174–175, 176, 276–278
- Global Commission on Adaptation** 474
- Global Drought Early Warning System (GDEWS)** 598
- global emissions pathways** 168, 170
- Global Environmental Facility (GEF)** 387, 388, 390
- Global Fire Emissions Database v.4 (GFED4s)** 148, 149
- global land cover map** 297
- global land system** 82–83, 87
current patterns in land use/cover 85–86, 85
future trends 88, 93–96
past and ongoing trends 86–88
status and dynamics 79, 84–88
- global mean surface air temperature*** see GSAT
- global mean surface temperature*** see GMST
- global warming*** 7–8, 140–142, 362
afforestation/reforestation and 49, 191
consequences of 44–45, 133, 140, 205, 277
climate feedbacks 136, 182–184, 183
climate variability changes 140
climate/weather extremes 144–148, 361–362, 464
for crop yields 451–454
for ecosystems 143–144, 251, 683
for fire regimes 149–150, 683–684
for food systems and security 142–143, 451–460, 463
hydrological changes 684
increased emissions 376–377
land cover and productivity changes 182–183, 183
for land degradation 347, 360–362
for livestock systems 454, 456, 458
for soil 184, 258
deforestation/forestation and 177–178, 179
delayed action 34
dryland water scarcity and 682–683
land cover change and 12, 47, 135, 171–172, 174–175, 205
net emissions reductions needed to limit to 2°C or 1.5°C 197–199, 686
Paris Agreement 81, 449, 480, 492, 701
regional climate change feedbacks 136, 182, 183
reversing after temperature overshoot 701
risk and 14–15, 15–17, 138, 251, 682, 683–686, 7.SM.7.1–3
socio-economic pathways and 684–686
vulnerable populations 278, 459–460, 464, 682–686, 691–692
see also 1.5°C warming; 2°C warming; 3°C warming; climate change
- Global Warming Potential (GWP)** 11*n*, 151*n*
- GMST (global mean surface temperature)*** 6, 7, 133, 140–142, 141, 142
impacts at different temperatures 680–686, 681, 685
impacts of 7.SM.7.1–3
projected 13, 675
risk as a function of 680, 681
- governance*** 28–29, 638, 679, 736–754, 5.SM.5.5
adaptation 471, 474
of biochar 400
of biofuels and bioenergy 738–739
capacity 743
climate change 5.SM.5.5
climate policy integration 103
combating desertification and dust storms 295
coordination 80
decentralised 287
definitions 679, 736
disaster risk response 744–745
enabling response to key challenges 103–104
experimentation 736, 742
FAQs 755–756
food systems and security 507, 5.SM.5.5
forest governance 709–711, 715–716
global experimentalist 5.SM.5.5
hybrid forms 737, 739
implementing sustainable land management 353
inclusive 80, 754
indicators of adaptive governance 753, 754
institutions 736–737, 5.SM.5.5
integrated 737–738, 5.SM.5.5
integrated watershed management (IWM) 304, 305
land governance 90–91, 374–375
land tenure 749–753, 751–752
levels and modes 737–738
market-based policies 105
modes 104
participation 745–746, 748–749, 748, 753
participatory governance 391, 743, 745–746
policy instruments 105–106
polycentric approach 104, 578, 737, 738, 5.SM.5.5
for sustainable development 737–738, 754
temporal scales 738
uncertainty, responding to 742–743
windows of opportunity 694–695, 756
see also policies
- government effectiveness (GE)** 638, 639
- graduation approach** 697, 698
- Grain for Green Program (GFGP)** 396
- grasslands** 281–283, 494
dryland areas 254–255, 256
impact of flooding 148
increased plant diversity 504
multi-species 504
N₂O emissions 162
productivity trends 366
projected land use change 461
soil compaction 596
see also reduced grassland conversion to cropland
- grazing land***
current land use 85–86, 85
dryland areas 254–255, 257
N₂O emissions 162
past and ongoing trends 86, 87
see also improved grazing land management

- grazing practices** 280, 281–282, 355, 376, 5.SM.5.3
- Greece** 453
- green infrastructure***
see urban green infrastructure
- Green Revolution** 469
- green walls/dams** 294–296, 297
- greenhouse gas (GHG)*** 81, 137, 205
impact of desertification 270
impact of land degradation 376–377
see also carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); ozone (O₃)
- greenhouse gas emissions** 6–7, 137, 139, 140, 376
agricultural 159, 160, 160, 161, 376, 475–478, 511, 702, 703
croplands and soils 159–160, 161, 162, 163, 476, 477
enteric fermentation 160, 189, 477
global trends 444, 445, 496
livestock 159, 160, 161, 162, 476, 477–478, 478, 5.SM.5.3
rice cultivation 159, 160, 477
see also AFOLU
anthropogenic see anthropogenic emissions
aquaculture and fisheries 478
bioenergy emissions 194, 196
by food type 513
calculating estimates 152–153
CO₂ equivalent (CO₂-eq) emissions 151
deforestation 176–177, 385–386, 388
desertification and 270
diet type and 479–480, 497–499, 513, 5.SM.5.4
fire emissions 149, 162, 270, 376, 397, 573, 7.SM.7.1
food system 475–480, 476, 477, 478, 490–491, 519
forest degradation 385–386, 388
global meat consumption 5.SM.5.4
hotspots 397
impact of delayed action 34
indirect land use change (iLUC) 194, 199
land degradation processes 376–377
mitigation pathways 195–196, 196, 197–199, 197
non-AFOLU 10–11, 151
over-consumption of food 490
peatland drainage and management 397, 398
permafrost thawing 134, 137, 184
rapid reduction 34, 79
rebound effect 477–478
reducing with biochar 398–399
reducing by dietary change 497–499
reducing with novel technologies 485–486
regional differences 155, 156, 158
soil emissions 134, 137, 184, 398–399, 476
spatial distribution 477, 478
traditional biomass use 375, 740
transport emissions 478–479
- greenhouse gas fluxes** 133–134
anthropogenic land CO₂ flux 8–9, 154
between land and atmosphere 151–165, 163–165
CH₄ 157–160, 158, 160
CO₂ 8–9, 152–157
gross emissions/removals 152, 157
N₂O 160–162, 163
total net flux of CO₂ 8, 152
bioenergy and BECCS 583
and climate change mitigation 701–702
desertification and 270
estimation methods and approaches 9, 134, 152–155, 154, 156, 163–164
forest CO₂ fluxes 154
future trends 200
GHGI reporting 164
GHGIs vs. global model estimates 134, 153, 154, 155
impact of extreme rainfall on carbon fluxes 148
land use effects 151, 151, 152–153, 159–160
LULUCF CO₂ fluxes 199–200, 200
managed/unmanaged lands 133–134, 139, 152, 152, 154, 155, 164
plant processes 201
policies 696, 701–705
- greenhouse gas inventories (GHGIs)** 9, 153–155, 156, 513
country reporting 164
vs. global model estimates 134, 153, 154, 155
- greenhouse gas removal (GGR)*** 188
- gross primary production (GPP)** 146
- groundwater**
depletion/exhaustion 271, 689
irrigation 584, 686, 734
oasis areas 301
over-extraction 271, 289
saltwater intrusion 401–402
vegetation and 268
- groundwater stress** 558
anthrome area exposed to 560
case studies 561–562, 563
global distribution 559
- growing season** 144, 182
- growth dilution** 463
- GSAT (global mean surface air temperature)***
land-to-climate feedbacks 182–184, 182, 183
response to land cover change 171–173, 172, 173, 174–175, 175
large-scale deforestation/forestation 177–180, 177, 243, 246–247
- gully erosion** 302, 303, 304, 359, 7.SM.7.1
- H**
- habitat degradation** 685, 7.SM.7.1
- Hadley circulation** 277
- halophytes** 283
- HANPP (Human Appropriation of Net Primary Production)** 87
- hazards*** 688, 732, 745
moral hazard 686–687
non-climatic 7.SM.7.1
policy response 688–689, 714, 726
see also reduced landslides
and natural hazards
- health** see human health
- heatwaves*** 7, 15, 133, 145, 146, 362
impact on food system and security 516
soil moisture and 135, 184
- hidden hunger** 442, 445–446, 469
- high latitude regions**
aquaculture 697
crop yields 680–681, 7.SM.7.1
land surface changes and climate feedbacks 183–184
see also boreal regions
- Hindu-Kush Himalayan Region** 452, 469
- hotspots**
desertification 292
GHG emissions 397
land degradation 365
threatened biodiversity 558, 559, 560, 562
- human activity**
and fire 148
interaction with land system 360
land degradation and 349, 367
vegetation changes attributed to 266
- Human Appropriation of Net Primary Production (HANPP)** 87
- human barriers to adaptation** 715
- human behaviour*** 722
as consumers 101–102, 105
and decision making 720
diet and lifestyle change 101, 618
modelling 96
- human behavioural change*** 105, 618, 722
- Human Development Index (HDI)** 633, 634, 5.SM.5.2
- human footprint** 367
- human health**
and air pollution 288, 451, 691
childhood stunting 445, 445, 446, 607
childhood wasting 445, 445, 446, 607
diet and 497–499, 498, 5.SM.5.4
economic costs 510
extreme temperatures 187, 447, 563
food safety 462–463
gender and climate change impacts 5.SM.5.1
impact of climate change 274, 462–463, 691
impact of dust storms 274
impact of food aid 464
impact of lack of clean water 402
infectious disease 590, 691
invasive plants 298, 299
malnutrition 442, 445–446, 445
micronutrient deficiency 442, 445–446
nutrition-related risks to 7.SM.7.2
obesity/overweight 444, 445, 445, 446
plant allergy 298, 299
policies 28, 510
respiratory disease 298, 299, 691
traditional biomass use 375, 740
undernourishment 442
and urban sprawl 594
urbanisation 187–188
- human systems***
climate-related risks 680–688, 688–689
communities and infrastructure 691–692
consequences of climate-land change 690–695
- Hungary** 453

- hunger** 460–462, 461, 495, 685–686
 hidden hunger 442, 445–446
 population at risk of 7.SM.7.1
- hurricanes** 7.SM.7.1
- hydrological cycle*** 205
 BVOC emissions and 169
 feedback to climate 138
 intensification 147, 360–362, 370–371
 response to deforestation 175–176
 role of forests 371
- hydrological systems** 355, 377
- hydroxyl radical (OH)** 158–159, 169, 170
- hyper-arid areas** 254, 255, 256, 257
 infrastructure 275
 oases 300–302
- I**
- ice-free land area** 5, 6–7, 558, 560, 633
 at risk of land degradation 365, 367
 overlapping challenges 560, 561
- ILK** see indigenous and local knowledge
- impacts***
 at different global mean surface temperatures 680–686, 681, 685, 7.SM.7.1–3
 of BVOCs on climate 169, 170
 of climate change see climate change impacts
 of climate variability
 on land 140–148, 205
 on livelihoods 516, 517, 518
 of compound events 144, 146
 of deforestation/forestation on climate 176–180
 of delayed action 34
 of desertification 270–276, 278–279
 of extreme weather and climate 143, 144–148, 145
 precipitation extremes 147–148
 temperature extremes 145–147
 of flooding 147–148
 of food systems on climate change 89–90, 90, 475–480
 of heat extremes and drought
 on food system and security 516
 on land 146–147
 of historical anthropogenic land cover change 171–174, 172, 173, 174
 of increased atmospheric CO₂ 144
 knowledge gaps 513
 of land-based CDR and bioenergy 492, 494
 of land cover change on climate 135, 171–182, 243, 243–247
 of land degradation on climate change 375–377, 382
 of land use and land cover 86–88, 87
 regional 84, 94
 of short-lived climate forcers 166, 167–168, 169, 170
- imported deforestation** 707, 709
- improved cropland management** 565, 566, 569
 adaptation potential 589, 590
 combined with bioenergy and BECCS 637
 feasibility 619, 6.SM.6.4.1
 future scenarios 634, 635
- impact on desertification 595, 595
 impact on food security 603, 604
 impact on land degradation 599, 600
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 mitigation potential 583, 584
 policy instruments 726
 potential across land challenges 609, 610, 611
 potential deployment area 633
- improved energy use in food systems** 567, 579
 adaptation potential 593, 594
 feasibility 622, 6.SM.6.4.1
 impact on desertification 598
 impact on food security 608, 608
 impact on land degradation 602
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 588, 588
 policy instruments 726
 potential across land challenges 610, 616
 sensitivity to climate change impacts 624
- improved food processing and retailing** 188, 491, 567, 579
 adaptation potential 593, 594
 feasibility 622, 6.SM.6.4.1
 impact on desertification 598
 impact on food security 608, 608
 impact on land degradation 602
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 588, 588
 policy instruments 726
 potential across land challenges 610, 616
 sensitivity to climate change impacts 624
- improved grazing land management** 566, 570
 adaptation potential 589, 590
 feasibility 619, 6.SM.6.4.1
 impact on desertification 595, 595
 impact on food security 604, 604
 impact on land degradation 599, 600
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 mitigation potential 583–584, 584
 potential across land challenges 609, 611
 potential deployment area 633
 sensitivity to climate change impacts 623
- improved livestock management** 493, 566, 570, 5.SM.5.3
 adaptation potential 589, 590
 combined with bioenergy and BECCS 637
 costs 102, 619
 feasibility 619, 6.SM.6.4.1
 impact on desertification 595, 595
 impact on food security 604, 604
 impact on land degradation 599, 600
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 interlinkages 636
 mitigation potential 584, 584
 potential across land challenges 609, 611
 potential deployment area 633
 sensitivity to climate change impacts 623
- inclusive governance** 80
- increased food productivity** 566, 569, 697
 adaptation potential 589, 590
 combined with bioenergy and BECCS 637
 feasibility 619, 6.SM.6.4.1
 impact on desertification 595, 595
 impact on food security 603, 604
 impact on land degradation 599, 600
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 interlinkages 636
 mitigation potential 583, 584
 policy instruments 726
 potential across land challenges 609, 610, 611
 potential deployment area 633
 sensitivity to climate change impacts 623
- increased soil organic carbon content** 382–383, 567, 572
 adaptation potential 591, 591
 feasibility 620, 6.SM.6.4.1
 impact on desertification 596, 596
 impact on food security 605, 606
 impact on land degradation 600, 601
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 mitigation potential 585, 586
 policy instruments 726
 potential across land challenges 609, 610, 613
 potential deployment area 633, 633
 sensitivity to climate change impacts 624
- incremental adaptation*** 466, 466, 467, 717, 747
- India**
 climate smart villages (CSV) 563
 crop production 452
 integrated watershed management (IWM) 304–305
 irrigation 180, 185–186
 monsoon 176, 180
 net forest area increase 98
 REDD+ 710–711
- indicators** 753, 754
- indigenous* and local knowledge* (ILK)** 104, 746, 746–748
 adaptation decision making 474
 addressing desertification 283–284
 addressing land degradation 384–385
 agricultural practices 29
 decision making 720
 dryland areas 258, 284
 food storage 472
 food systems and security 512
 informing mitigation and adaptations options 755
 mitigation and adaptation strategies 470
 response option implementation 638
 supply side adaptation 471, 472
 urbanisation 289
- indigenous food systems** 469, 738
- indigenous peoples** 27, 28–29, 43, 62, 80, 746–748
 adaptive capacity 470, 755
 land rights 91, 106, 749–750
 stakeholder involvement and decision making 104, 638, 640, 710, 720
- indirect aerosol effect** 169, 170, 192

- indirect land-use change (iLUC)** 54, 194, 199
- Indonesia** 385, 474, 562, 588
 mangrove deforestation 402, 487
 peatlands 397–398
- Indus delta** 401–402
- inequality***
 barrier to climate action 716
 gender 353, 639, 716, 717–718
 and land degradation 347
 in land use and management 353
 and maladaptation 474
 reduced 631–632
 social 481, 744, 754
 in SSPs 13, 92–93
 of water management benefits 304, 305
 wealth and power 716
- informal institutions** 720, 747
- infrastructure**
 areas 85, 86
 coastal 7.SM.7.2
 green infrastructure 735
 risks to 275, 684, 691–692
- insect-based diets** 490
- institutional barriers** 618, 619–623, 715–716, 715, 737, 738, 6.SM.6.4.1
- institutional capacity*** 33
- institutional dimensions** 753, 754
- institutions*** 507, 640, 5.SM.5.5
 adaptation measures 473–475
 adaptive 736–737
 based on ILK 747
 building adaptive and mitigative capacity 736–737
 decision making 720
 local 287
- insurance** 102, 467, 511, 700, 712
 crop insurance 580, 588–589, 594, 599, 603, 608, 699
 flood insurance 701, 744
 social protection policies 699
 see also risk sharing instruments
- integrated agricultural systems** 499–502, 504
- integrated assessment models (IAMs)*** 95, 163, 195, 641, 643
 bioenergy and BECCS 30, 581, 582
 integrated response options 634–638, 635, 636, 6.SM.6.5.4
 socioeconomic development, mitigation responses and land 30, 32
- integrated catchment management** 561–562
- integrated coastal zone management** 566–567
- integrated crop-soil-water management** 280–281, 280
- integrated landscape management** 566–567
- integrated response options*** 18–19, 61–63, 63–66, 551–672, 565–569, 566
 adverse side effects 627, 628–629, 630, 631–632, 633
 barriers to implementation 618, 619–623, 638, 6.SM.6.4.1
 co-benefits 627, 628–629, 630, 631–632, 633
 delayed action 554, 644–645
 enabling conditions 554, 558, 633
- FAQs 646
 feasibility 618, 619–623
 framing within social-ecological systems (SES) 556–558, 557
 future scenarios 634, 635
 IAMs and non-IAMs studies 634–638, 635, 636, 6.SM.6.5.4
 impact on NCP 627, 628–629, 6.SM.6.4.3
 impact on SDGs 627, 630, 631–632, 6.SM.6.4.3
 implementation 18, 633–645
 challenges 638–640
 coordination 640
 stakeholder involvement 638–639
 interactions and interlinkages 636–638, 636, 637
 knowledge gaps 638
 land management based
 see land management response options
 mapped from SR15 568, 569
 overarching frameworks 565–566, 566–567
 overlapping challenges 609–610, 633
 potential 583–610, 609, 611–617
 for addressing desertification 595–599
 for addressing food security 603–608, 609
 for addressing land degradation 599–603
 for delivering adaptation 589–594, 609–610
 for delivering mitigation 583–589, 609–610
 global contribution 24–26
 potential deployment area 633, 633, 634
 risk management based
 see risk management response options
 sensitivity to climate change impacts 623–624
 size of negative/positive impact 609–610, 609, 611–617
 synergies and trade-offs 627, 636–637
 value chain management based
 see demand management response options;
 supply management response options
- integrated soil fertility management** 383
- integrated water management** 567, 571
 adaptation potential 589–590, 590
 combined with bioenergy and BECCS 637
 feasibility 619, 6.SM.6.4.1
 impact on desertification 595, 595
 impact on food security 604, 604
 impact on land degradation 599, 600
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 mitigation potential 584, 584
 policy instruments 726
 potential across land challenges 611
 sensitivity to climate change impacts 623
- integrated watershed management (IWM)** 302–305, 303, 304
- intercropping** 280–281, 384, 504
- interdisciplinary work** 106, 268, 514
- interlinkages** 61–66
 adaptive governance 743–745
 between integrated response options 636–638, 636, 637
 between land challenges 551–672
 between land challenges and local response 561–563
- desertification, land degradation, food security and GHG fluxes 551–672
 land, water, energy and food sectors 743–745
 migration, conflict and climate change 380–381
 poverty, land degradation and climate change 378–379, 379
 of SDGs 506, 507
 see also integrated response options
- intra-linkages of SDGs** 506, 507
- invasive species** 358, 707
 invertebrates 355
 plants 259, 262, 297–300, 298, 355
- invasive species/encroachment management** 567, 574
 adaptation potential 591
 feasibility 621, 6.SM.6.4.1
 impact on desertification 597
 impact on food security 606
 impact on land degradation 601
 impact on NCP 628, 6.SM.6.4.3
 impact on SDGs 631, 6.SM.6.4.3
 mitigation potential 586
 policy instruments 726
 potential across land challenges 614
 sensitivity to climate change impacts 624
- investment** 33–34, 645
 crop expansion 602
 food system 511
 irrigation 288–289
 land degradation responses 381–382
 land restoration programmes 396
 research and development 287–288
 sustainable land management (SLM) 285, 387, 390, 391
- IPBES Land Degradation and Restoration Assessment report** 256, 259, 388, 746
- IPCC Fifth Assessment Report (AR5)**
 desertification 256
 ecosystem change 143, 371
 food system 448–449, 450
 indigenous and local knowledge 746
 land aerosols emission 166
 land degradation 350
 land-climate interactions 137–138
 maladaptation 734
 precipitation 361
 risk 679
- IPCC Special Report on Climate Change and Land (SRCCL)**
 interdisciplinary nature 106
 objectives and scope 81–84, 83
 overview 84
- IPCC Special Report on Emission Scenarios (SRES)** 175
- IPCC Special Report on Extreme Events (SREX)** 83, 351
- IPCC Special Report on Global Warming of 1.5°C (SR15)** 83, 362
 bioenergy and CDR 373
 crop productivity changes 454
 desertification 256
 food security 449
 indigenous and local knowledge 746

- land-climate interactions 137
 - precipitation 361
 - risk 679
 - IPCC Special Report on Land Use, Land-Use Change and Forestry (SR-LULUCF)** 350–351
 - Iran** 264, 278, 402, 460, 470
 - irreversibility*** 69, 645, 681, 685, 687
 - irrigation** 86, 254, 595, 731
 - combined forestation and irrigation 185, 185
 - development and investment 288–289
 - downwind and non-local climate effects 185–186, 185
 - excessive water use and soil erosion 293, 294
 - groundwater extraction 401, 402, 563, 686, 734
 - impacts on climate 180, 181
 - integrated crop-soil-water management 280
 - land and water rights 749, 750
 - oasis agriculture 301
 - risks of 686
 - isoprene epoxydiol-derived SOA (IEPOX-SOA)** 169
 - IWM** see integrated watershed management
- J**
- Jordan, Badia region** 302–304
 - Just Transitions** 511
- K**
- Karapinar, Turkey** 292–293, 293
 - Kenya** 263, 380, 384, 448, 460
 - agricultural commercialisation 289
 - pastoral systems 287, 457
 - knowledge gaps**
 - desertification 305–306
 - dust storms 277
 - emissions 513
 - food system and security 511, 513–514
 - integrated response options 638
 - interlinkages 755
 - land degradation 403–404
 - risk management and decision making for sustainable development 755
 - traditional biomass 741–742
 - knowledge transfer** 33, 512
- L**
- La Niña** 146, 149, 305, 591
 - land*** 40–43
 - area required for bioenergy 687–688, 687, 739, 7.SM.7.1, 7.SM.7.3
 - climate drivers of form and function 140
 - and climate policies 678
 - climate-related extremes 133, 138
 - CO₂ source and sink 8
 - competing demand 373, 449, 470, 492, 494, 502
 - contribution to climate change 205
 - defined 4*n*, 349
 - demand for 750, 756
 - grazing value 272
 - human use 5, 6–7
 - impact of delayed action 34
 - land-climate interactions 107
 - natural response to human induced environmental change 8–9, 10–11, 151, 154
 - warming 6, 7–8, 140–142
 - land abandonment** 518
 - land-atmosphere exchanges**, and fire 149
 - land-atmosphere feedback loops** 268
 - land-based mitigation** 752, 756
 - barriers to 715–716
 - land challenges*** 558–565, 561–563, 565, 642–644
 - consequences of delayed action 554, 644–645
 - future scenarios 564, 565
 - historic and local response to 561–563
 - impact of bioenergy and BECCS 580–583
 - interaction with response options 638
 - local 633
 - overarching frameworks for addressing 565–566, 566–567, 600
 - overlapping 558, 560, 561, 561, 561–563, 633, 633, 634
 - policy responses 27–29
 - response options
 - see integrated response options
 - spatial distribution 558, 559
 - land-climate interactions** 5, 44–49, 131–248, 625–626
 - albedo and land use change 138, 177
 - biogeochemical interactions 140, 176–177, 177
 - biogeochemical warming 172–173, 173, 174–175, 174, 175, 176–177
 - GHG fluxes 151–162, 163–165
 - regional 172
 - biophysical interactions 139, 177, 177
 - biophysical cooling 172–173, 173, 174–175, 174, 175
 - biophysical warming 174, 175
 - regional 172–173, 174, 175
 - climate variability/change and impacts on land 1, 133, 140–148, 205
 - changes in aridity 142
 - changes in terrestrial ecosystems 143–144
 - climate extremes 138, 143, 144–148, 145
 - food security 142–143
 - global land surface air temperature 140–142, 141, 142
 - heavy precipitation 137, 147–148
 - soil carbon response to warming 203–204
 - temperature extremes, heatwaves and drought 145–147
 - thermal response of plant and ecosystem production 201–202
 - water transport 202
 - cooling response 177, 194
 - ES/NCP concepts 625–626
 - FAQs 107, 205
 - future terrestrial carbon source/sink 137
 - hydrological feedback to climate 138
 - land area precipitation change 137
 - land-based climate change adaptation and mitigation 138
 - land-based GHGs 137
 - land-based water cycle changes 137, 202
 - land-climate feedbacks 149, 182–184, 182, 183
 - land cover change and impacts on climate 171–176, 205
 - amplifying/dampening climate changes 182–184, 182, 183
 - deforestation/forestation 176–180
 - global climate 171–172, 171, 172, 173, 174–175, 175
 - regional climate 171, 172–174, 174, 175–176, 176
 - urbanisation 186–188
 - land management impacts 180–182, 181
 - land processes underlying 139–140
 - plant and soil processes 201–204
 - previous IPCC and other reports 137–138
 - regional variations 191–192
 - response options effect on climate 188–201
 - mitigation pathways 195–199, 196, 197, 198
 - SLCFs emissions and impacts 166–170
 - warming response 194
- land cover*** 79, 84–88, 297
 - biophysical climate interactions 135, 139
 - climate feedbacks 135, 182–184, 182, 183
 - dryland areas 254–255, 256
 - impact of climate change 205
 - impact of precipitation extremes 147–148
 - remote sensing 367, 368
- land cover change*** 12, 85–88, 171, 369
 - and albedo 12, 181–182, 183–184, 374
 - and BVOC emission 170
 - due to global warming 182–183
 - impact on climate 135, 171–176, 243, 243–247
 - deforestation/forestation 176–180
 - land management changes 180–182
 - net anthropogenic CO₂ flux 151
 - non-local and downwind effects 135, 184–186, 185
 - pathways 30–32, 195–199, 197, 642–644
- land degradation*** 6–7, 53–56, 84, 88–89, 345–436, 558, 689
 - adaptation limits 388
 - addressing 21, 381–403
 - barriers to SLM implementation 389–391
 - local responses 561–563
 - near-term action 33–34
 - on-the-ground actions 381–384
 - potential for 24–26, 599–603, 609–610, 609, 611–617
 - agricultural land 373, 376
 - assessment approaches 363–367
 - attribution 360, 362, 363, 404
 - case studies 391–403, 392, 561–563
 - challenge 559, 560, 561, 564, 565
 - and climate change 5, 7–8, 353–365, 356–359
 - climate-change-related drivers 359
 - complex linkages 360, 362–363
 - direct impacts 360–362, 367–368, 369–373
 - indirect impacts 362–363, 369, 373
 - land management interactions 351, 352
 - climate-induced vegetation change 361, 367–368, 371–372

- coastal areas 372–373, 392, 400–403, 401
- costs 692–693
- defined 4*n*, 88, 107, 254, 349–350
- difference from desertification 107, 254
- diverging and conflicting views 349, 350, 365, 404
- drivers 354, 359–360, 360, 361, 382
- dust emissions 377
- FAQs 107, 646
- feedbacks on climate 356–359, 375–377, 382
- financing mechanisms 712
- and fire 149
- future scenarios 564, 565, 634, 635
- global status and trends 365–369, 559
- hotspots 365
- human activity and 349, 367
- impact on food security 379–380, 604
- impact on greenhouse gases (GHGs) 376–377
- impact on migration and conflict 380–381
- impact on poverty and livelihoods 377–379
- impacts of bioenergy and CDR technologies 373–375, 601–602, 602, 615
- impacts of integrated response options 599–603, 609–610, 609, 611–617
- indigenous and local knowledge (ILK) 384–385
- intensified land use and 502, 505
- knowledge gaps 403–404
- land degradation neutrality (LDN) 20, 27, 52, 387–388, 705–706, 705
- and land tenure 752
- local communities and 353
- mapping with biophysical models 262
- physical effects 377
- policy responses 27, 387–388, 696, 705–711, 705
- previous reports 350–351, 388
- processes 354–356, 356–359, 369–373
- projections 369–373
- recovery rates 359
- resilience 388–389
- risks from bioenergy and land-based CDR 373–374
- risks from climate change 369–373, 681, 682, 683–684, 7.SM.7.1, 7.SM.7.3
 - under different SSPs 684–685, 685, 7.SM.7.1, 7.SM.7.3
- seminatural ecosystems 376
- socio-economic drivers 359–360
- socio-economic impacts of 377–381
- soil carbon loss 381
- surface albedo change 377
- thresholds 389
- traditional biomass use 375, 740–741
- uncertainty in risk assessment 369
- urban areas 186, 188
- water erosion risk 370–371
 - see also desertification; forest degradation
- land degradation neutrality (LDN)*** 387–388, 566, 705, 705–706
 - achieving targets 294, 296, 305
 - concept 350
 - framework elements 286
 - policies promoting 20, 27, 52
 - in SSPs 727
- Land Degradation Neutrality Fund** 712
- land governance** 90–91, 374–375
- land grabbing** 91, 750, 751
- land management***
 - ecosystems and climate change 84
 - futures analysis and decision making 80
 - gender inequality 353
 - GHG emissions 79, 81
 - impacts on climate 180–182
 - informed by ILK 755
 - interactions with climate change impacts 351, 352
 - non-local and downwind effects 184–186, 185
 - protected areas 100
 - soil erosion and projected rainfall 371
- land management response options** 97, 100, 189–193, 611–615
 - agriculture see agricultural response options
 - all/other ecosystems 573–575, 614
 - adaptation potential 591–592, 592, 614
 - feasibility 621, 6.SM.6.4.1
 - impact on desertification 597, 597, 614
 - impact on food security 606, 606, 614
 - impact on land degradation 601, 601, 614
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 586, 587, 614
 - policy instruments 726
 - potential across land challenges 614
 - sensitivity to climate change impacts 624
 - co-benefits 633
 - for CO₂ removal 97, 575–576, 580–583, 610
 - adaptation potential 592, 592
 - feasibility 621, 6.SM.6.4.1
 - impact on desertification 597, 597
 - impact on food security 607, 607
 - impact on land degradation 601–602, 602
 - impact on NCP 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 587, 587
 - policy instruments 726
 - potential across land challenges 615
 - risks of 686–688, 687
 - sensitivity to climate change impacts 624
 - demand for land 18–19, 24–26, 97
 - feasibility 618, 619–621, 6.SM.6.4.1
 - forests see forest response options
 - global potential 24–26
 - impact on NCP 627, 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - implementation 633
 - mitigation potential 190, 586, 587, 587
 - policy instruments 726
 - potential across land challenges 611–615
 - potential deployment area 633, 633
 - sensitivity to climate change impacts 624
 - soils see soil-based response options
- land ownership** see land tenure
- land pathways** 30–32, 641–644
- land productivity** 182–183, 183, 365, 366, 367
- land rehabilitation*** 351
- land resources** 79, 80, 104–105
- land restoration*** 33–34, 294–295, 351, 396
 - financing mechanisms 712
 - Karapinar wind erosion area 293, 293
 - returns from 285
 - see also restoration and reduced conversion of coastal wetlands; restoration and reduced conversion of peatlands
- land rights** 29, 353, 709–711
 - barrier to climate action 715
- land sharing** 502–505
- land sink** 84, 154, 165
 - process 153, 155–157
- land sparing** 488, 489, 502–505, 636
- land surface air temperature*** see LSAT
- land surface models** 202
- land system models** 634–638, 635, 636
- land systems**
 - global 79, 84–88
 - human interactions with 360
 - risks from climate change 133, 680–686, 681
- land tenure** 27, 695, 749–753, 751–752
 - barrier to climate action 715
 - forest rights 710–711
 - indigenous and community land rights 106, 709–711
 - land grabbing 91, 750, 751
 - security 287, 383, 719
- land use*** 5, 6–7, 79
 - anthromes and land challenges 558, 559–560, 561, 561–563
 - BVOC emissions 135, 170
 - carbon dioxide (CO₂) emissions 133–134, 135–136, 151–157
 - and climate change 84–85, 133, 134–135, 205, 404, 462
 - and desertification 89
 - dietary habits and 79–80, 472–473, 487–489
 - dryland areas 254–255, 256, 257
 - FAQs 205, 404
 - and food loss and waste 490–491
 - food system 79–80, 90, 472–473, 487–489
 - future pathways 22–23, 30–32, 88, 93–96, 195, 373, 641–644
 - GHG fluxes 8–9, 79, 81, 84, 133–134, 135–136, 151–162, 163–165
 - global patterns 6, 79, 82, 84–88, 85, 87, 559–560
 - integrated landscape initiatives 738
 - intensity 82–83, 86, 502–505
 - and land degradation 88–89, 404
 - methane (CH₄) emissions 84, 133–134, 136, 151, 159–160, 160
 - mitigation response options 79, 97, 98–100, 100, 135–136, 373–374, 487–489, 641–644
 - nitrous oxide (N₂O) emissions 133–134, 136, 151, 160–162, 161, 163
 - observations 91–92
 - policies and governance 737–738, 738–739, 748–749, 751–752
 - pressures and impacts 87
 - rotational 157
 - suitability for CDR 374
 - transition from livestock production 511
 - uncertainties related to 91–93, 96

- land-use change (LUC)*** 5, 6
 assessing 91
 biodiversity losses 88
 bioenergy expansion 739
 BVOC emissions 170
 carbonaceous aerosols emissions 168
 climate drivers 93
 CO₂ emissions 10–11, 195–196, 198
 competition for land 90–91
 drivers 79, 93, 373
 impact on climate 138
 impact on food systems and security 461, 462, 514
 key challenges 88–96
 large-scale CDR 19, 492, 494
 large-scale conversion non-forest to forest land 98–100
 measuring and monitoring 33
 projected 30–32, 196–197, 197, 461, 462, 642
 regional variation 462
 response options and 18–19, 22–23, 25–26, 188
 socio-economic drivers 79, 93
 soil N₂O emissions 162
 urbanisation 186
- land use land cover change (LULCC)** 174, 176
- land use, land-use change and forestry (LULUCF)*** 154, 199–200, 200
- land-use zoning** 706
- landscape approaches** 505
- landscape integration** 738
- landscape transformations** 756
- landslides** 370, 7.SM.7.1
see also reduced landslides and natural hazards
- large-scale land acquisition (LSLA)** 91, 750, 751
- Latin America and Caribbean** 159, 751
- leakage*** 702
- learning** 736–737
- legal instruments** 105, 701
- lifecycle analysis/assessment (LCA)*** 490, 721
- likelihood*** 4*n*, 92, 363
- Limpopo River basin** 263, 305
- livelihood diversification** 285, 471, 567, 579
 adaptation potential 594, 594
 feasibility 623, 6.SM.6.4.1
 impact on desertification 598, 599
 impact on food security 608, 609
 impact on land degradation 603, 603
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 588
 policy instruments 726
 potential across land challenges 610, 617
 sensitivity to climate change impacts 624
- livelihoods*** 5, 79
 and agricultural productivity 604
 climate stressors 690–691
 coastal 7.SM.7.2
 dryland areas 257–258, 304, 684, 685
 food systems and security 90, 5.SM.5.2
 gender and climate change impacts 5.SM.5.1
 impact of climate variability/extremes 516, 517, 518
 impact of climate-related land degradation 377–379, 380, 388
 impact of peatland degradation 397–398
 impact of vegetation degradation 683
 and migration 690–691
 near-term actions 33–34
 oasis populations 301
 Pacific island communities 517
 pastoral 457–458
 risks to 683, 684, 685
 safety nets 380
 synergies and trade-offs 5.SM.5.3
 women's 717–718
see also livelihood diversification
- livestock**
 enteric fermentation 160, 189, 477, 484
 feed 276, 444, 456–457, 473, 485, 5.SM.5.3
 genetics 513
 GHG emissions 22, 477–478, 478, 5.SM.5.3
 reduction methods 486, 5.SM.5.3
 higher temperatures and 455, 455, 456
 impact of climate change 276, 454–458, 455, 5.SM.5.2
 manure and N₂O emissions 11, 162, 376, 477, 478, 5.SM.5.3
 meat production and dietary consumption 473, 479–480, 487–490, 604, 5.SM.5.4
 methane (CH₄) emissions 79, 134, 159, 477–478, 486
 pests and diseases 456, 457, 458
see also improved livestock management
- livestock production systems**
 adaptation options 22, 471
 crop-livestock integration 384, 485–486, 504
 current land use 85–86
 dairy systems 483
 diversification 589
 economic mitigation potential 483, 486
 GHG emissions 159, 160, 161, 162, 476, 477–478, 478
 grazing and fire management 281–283
 impacts of climate change 454–458, 455
 intensive and localised herding 302
 migratory livestock systems 257, 293
 mitigation strategies 22, 483, 484, 485–486, 5.SM.5.3
 past and ongoing trends 86, 87
 peatlands 606
 productivity 454–458, 455
 smallholder systems 459–460
 sustainable intensification 481–482
 technical mitigation potential 483, 484, 485–486
 transition away from 511
see also livestock; pastoralists
- Local Adaptation Plan of Action (LAPA)** 474
- local institutions** 287
- local knowledge***
see indigenous and local knowledge
- local seeds** 468, 567, 579
 adaptation potential 594, 594
 feasibility 623, 6.SM.6.4.1
 impact on desertification 598, 599
 impact on food security 608, 609
 impact on land degradation 603, 603
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 588
 policy instruments 726
 potential across land challenges 610, 617
 sensitivity to climate change impacts 624
- lock-in*** 645
- logging practices** 351–352, 353, 376
 illegal 716
 NFPP policy in China 396
- long-term projections** 94
- low-carbon economies** 713
- low latitude regions** 67, 372
 aquaculture 697
 crop yields 143, 680–681, 681
 drought trends 146
- low-regret measures** 83
- LSAT (land surface air temperature)*** 7, 133, 140–142, 141, 142
 changes in annual mean 177, 186–187
 and desertification 251
 extremes 174, 176
 and land sink 155
 land-to-climate feedbacks 182–184, 182, 183
 observed mean 6, 7, 44
 regional temperature changes 172–174, 174, 175, 177–180, 177
 response to land cover change 135, 171, 172–174, 184–185
 large-scale deforestation/forestation 177–180, 177
 response to land management change 180
 cropland albedo 181–182, 181
 irrigation 180, 181
 response to urbanisation 186–187
 seasonal changes 172–174, 174, 182–183
 and soil moisture 145, 184
- LSLA** *see* large-scale land acquisition
- LUC** *see* land-use change
- LULCC** *see* land use land cover change
- LULUCF** *see* land use, land-use change and forestry
- ## M
- maladaptation/maladaptive actions*** 103, 734
 avoiding coastal maladaptation 392, 402–403
 flood insurance 701
 inequalities and 474
 to desertification 20, 291–292
- Malawi** 289, 582, 744
- malnutrition*** 607
 climate change and food quality 463–464
 climate related risks to nutrition 7.SM.7.1
 defining 442
 food prices and 495, 497
 gendered approach to health and nutrition 5.SM.5.1
 global trends 445–446, 445
 Hindu-Kush Himalayan Region 469
 protein deficiency 463–464
 risk of hunger 685–686
- managed forest*** 155, 164, 191, 194, 562

- managed land*** 133–134, 139, 152, 152, 154, 155, 164, 194
- management of supply chains** 567, 578
 adaptation potential 593, 594
 feasibility 622, 6.SM.6.4.1
 impact on desertification 598
 impact on food security 607–608, 608
 impact on land degradation 602
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 institutional barriers 618, 6.SM.6.4.1
 mitigation potential 588
 policy instruments 726
 potential across land challenges 610, 616
 sensitivity to climate change impacts 624
- management of urban sprawl** 567, 579
 adaptation potential 594, 594
 feasibility 623, 6.SM.6.4.1
 impact on desertification 598, 599
 impact on food security 608, 609
 impact on land degradation 603, 603
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 588
 policy instruments 726
 potential across land challenges 617
 sensitivity to climate change impacts 624
- mangroves** 193, 400, 401, 401
 climate related risks 7.SM.7.1
 deforestation 402, 487, 590
- manure** 160, 161, 162, 189
 GHG emissions 477, 478
 green manure cover crops 181–182, 192, 376, 471
 management 483, 484, 5.SM.5.3
- marginal abatement cost curves (MACCs)** 102
- market access** 286
- market-based instruments** 105, 702, 703, 725
- market failure*** 508
- material substitution** 567, 577
 adaptation potential 593
 feasibility 622, 6.SM.6.4.1
 impact on desertification 598
 impact on food security 607, 607
 impact on land degradation 602, 602
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 587, 588
 policy instruments 726
 potential across land challenges 615
 sensitivity to climate change impacts 624
- mean global annual temperature** 177–178
- measurement, reporting and verification (MRV)*** 29
- meat consumption** 489, 498–499, 5.SM.5.3, 5.SM.5.4
- Mechanized Micro Rainwater Harvesting (MIRWH)** 303–304, 303
- 'Mediterranean' diet** 488, 489, 497, 498
- Mediterranean region**
 crop yields 56
 desertification 264, 682
 drought 15, 45, 146, 682
 drylands 264, 277, 278–279
 erosion and projected rainfall 302, 362, 370
 fire risk 69, 684
 water scarcity 682, 683
- megadroughts*** 145, 145
- mesoscale convective systems (MCS)** 370
- mesquite** 298, 299
- metal toxicity** 357
- methane (CH₄)*** 157–160, 158, 160, 366–367, 451, 703
 AFOLU emissions 8–11, 10–11
 agricultural emissions 6–7, 84, 160, 195, 196, 476
 enteric fermentation 160, 189, 477
 livestock 79, 134, 159, 477–478, 486
 rice cultivation 11, 79, 134, 159, 160, 476, 477
 anthropogenic emissions 134, 151
 atmospheric lifetime 169, 170, 192
 atmospheric trends 157–159
 emissions from flooded soil 398
 emissions from peatlands 159–160, 476, 477, 586
 emissions from permafrost thawing 137, 184
 emissions from wetlands 157–158, 159
 fire emissions 149
 globally averaged atmospheric concentration 11, 157
 land degradation and 376, 377
 land use effects 159–160, 195, 196
 mitigation options 486
 non-AFOLU emissions 10–11, 151
 projected emissions 195–196, 196, 198, 199
- Mexico**
 agriculture 402, 460, 518
 drylands 265, 402
 invasive plants 299
 livelihoods 447, 603
 migration 285, 518
 salinisation of agricultural land 402
- microfinance services (MFS)** 475
- microinsurance** 712
- micrometeorological flux measurements** 164
- micronutrient deficiency** 442, 445–446, 463–464
- mid latitudes**
 bioenergy crops 194
 crop yields 7.SM.7.1
 forests 368
 impact of deforestation 174, 179
 precipitation 137
 snow cover 184
- Middle East** 264, 292–293, 293, 302–304
- migration*** 16, 285, 690–691
 adaptation strategy 285, 380, 388, 683
 climate change and 259
 desertification and 380–381
 dryland areas 259
 due to long-term deterioration in habitability 690, 691
 environmental risk response 275–276
 food security and 516–518, 517
 impact on biodiversity 691
 of labour 289
 land degradation and 380–381
 Pacific region 517, 518
- Millennium Ecosystem Assessment (MA)** 625–626
- mineral dust** see dust
- mitigation (of climate change)*** 80, 138, 642–644, 646
 adaptation co-benefits and synergies 22, 102–103, 383, 391, 392
 with food security 448, 492, 493, 500, 507, 513–514
 agriculture 181–182, 281, 282
 barriers for 188, 292, 513
 co-benefits 102–103
 costs 102
 decision making approaches 721–723
 demand-side mitigation 487–491, 513–514
 dietary changes 472–473
 financing mechanisms 711–712
 food system 21–22, 101, 443, 449, 480–491, 513–514
 food system interlinkages 441
 future scenarios 13, 564, 565
 governance 737–738, 5.SM.5.5
 green walls/dams programmes 294–296
 and greenhouse gas fluxes 157, 701–702
 impact on food prices 494–497, 495
 integrated pathways 195–199
 knowledge gaps 513
 and land tenure 751–752
 market-led response 105
 near-term actions 33–34
 policies 27–28, 509, 696, 701–702, 714
 renewable/green energy and transport 735
 risk associated with 686–688, 689
 supply-side mitigation 101, 480–487, 484, 513–514
 synergies with adaptation and food security 448
- mitigation failure** 686–687
- mitigation measures*** 19, 695
 barriers to 715–716
 gender inclusive approach 43, 717–719
- mitigation options*** 18–23, 24–26, 81, 135–136, 188–199, 583–589
 adverse side effects 687–688, 718
 agriculture 480–486, 583–584
 agroforestry 383, 485, 485
 in aquaculture 486–487
 barriers 79
 biochar 100, 398–400
 cellular agriculture and cultured meat 487
 demand management 101–102, 587
 dietary change 487–490, 488, 497–499
 estimating costs 102
 FAQs 107, 646, 755
 food system 480–491, 509, 513–514
 forest-based 99–100, 584–585
 global potential 24–26
 impact on land degradation 373–375
 land management 586–587
 land use 79, 97, 98–100, 100, 373–374, 487–489, 641–644
 land-demanding 34, 79, 97, 98–100, 196–197
 region-specific impacts 107
 renewable energy 288, 486
 risk management options 102, 588–589
 shortening supply chains 491

- soil management 100, 382–383, 483, 585–586
 supply management 100–101, 588
 sustainable intensification 481–482, 501–502, 502–505
 urban green infrastructure (UGI) 188, 392–393
 urban and per-urban agriculture* 505, 507
see also REDD+
- mitigation pathways*** 34, 195–199, 196, 197, 198
 archetypes 198–199, 198
 assumptions 195
 economics of 102
 from the food system 480
 GHG mitigation in croplands and soils 483
 linking socioeconomic development and land use 30–32
- mitigation potential** 189, 190, 193–195, 201, 583–589, 609–610, 609, 610, 611–617
 agricultural response options 189, 190, 483, 583–584, 584, 611
 combined land response options 636–637
 demand management options 191, 195, 587, 588, 615
 dietary mitigation potential 487–490, 488, 497–499
 economic potential 189, 483, 486, 489
 of food systems 449, 487–491, 497–499
 forest response options 189–192, 584–585, 585, 612
 land management options 583–587, 611–615
 all/other ecosystems 193, 586, 587, 614
 specifically for CDR 193–194, 587, 587, 615
 risk management 588–589, 589, 617
 soil-based response options 192–193, 483, 585–586, 586, 613
 supply management options 490–491, 588, 588, 616
 uncertainties 489–490, 5.SM.5.3
- mitigation scenarios*** 95, 634, 635
 bioenergy and BECCS in 580–583
 forest area expansion 99–100
 with large land requirements 19, 97
- mitigation strategies** 197–199
 integrating cultural beliefs and ILK 470
 Karapinar wind erosion area 293
 livestock mitigation strategies 5.SM.5.3
 novel technologies 485–486
- mixed farming** 384, 500
- models**
 evaluation and testing 95–96
 futures analysis 80, 93–96
 uncertainties 92–93
see also specific types of model
- Moderate Resolution Imaging Spectroradiometer (MODIS)** 363
- monitoring, reporting and verification (MRV)** 702, 703
- monsoons** 176, 176, 277
- moral hazard** 686–687
- Morocco** 263, 284
 drought and conflict 518
 oases 300, 300, 301
- mountain regions** 185, 294, 301, 452, 469, 591
- multi-criteria decision making** 721
- multi-level governance*** 391, 737–738, 742
- multi-level policy instruments** 695–696, 696
- multi-species grasslands** 504
- multiple policy pathways** 510
- mycotoxins** 462, 463
- ## N
- National Adaptation Plans (NAPs)** 387, 473
- National Adaptation Programs of Action (NAPAs)** 473
- National Forest Protection Program (NFPP)** 396
- Nationally Determined Contributions (NDCs)*** 81, 199–201, 200, 387, 562
 agricultural adaptation and mitigation 449
 CO₂ mitigation potential 199–200, 200
 food systems 449
 land-use sectors 704–705
 LULUCF contribution 200, 200
 traditional biomass use 375
- natural capital accounting** 511
- natural disasters** 590, 592, 699, 743–745
 and food security 518, 743–744
 and migration 276, 518
 planning 738, 744
see also landslides; tropical cyclones
- natural grasslands** 85, 86
- natural land** 30–32
- natural resource management** 287
- Nature-Based Solutions** 381, 391, 403, 566–567
- NCP (Nature's Contributions to People)** 500–501, 625–626
 impacts of integrated response options 627, 628–629, 6.SM.6.4.3
 urban areas 603
- NDVI (Normalised Difference Vegetation Index)** 261–262, 261, 363, 365
 as proxy for NPP 363
- near-term action** 33–34, 554–555, 644–645
 costs vs. benefits 102
 pathways 198–199
- negative emissions*** 135–136, 374, 386, 387, 686
see also carbon dioxide removal (CDR)
- negative emissions technologies*** 348, 398, 399, 441, 492
- neglected and underutilised species (NUS)** 469
- Nepal** 469, 474
- net negative emissions*** 198, 580
- net primary production/productivity** *see* NPP
- net-zero emissions*** 703
- nexus approach** 103, 514, 731, 739
- NFPP (National Forest Protection Program)** 396
- NGOs (non-governmental organisations)** 737
- Niger Basin** 370
- Nigeria** 452–453
- nitrogen addition to soils** 134, 159, 162, 163, 203
 emissions 162, 476, 477
- nitrogen cycle** 202–203
- nitrous oxide (N₂O)*** 160–162, 161, 163, 366–367, 703
 AFOLU emissions 8–11, 10–11
- agricultural emissions 6, 79, 84, 134, 195, 476, 478, 5.SM.5.3
 anthropogenic emissions 134, 151
 aquaculture emissions 478
 atmospheric trends 160–162, 161
 cropland emissions 134, 181–182
 data sources 160–161
 fertilizer application and 134, 181–182, 476, 477
 fire emissions 149
 food system emissions 478, 479
 grazing land emissions 134
 land degradation and 376, 377
 land use effects 162, 163
 livestock system emissions 134, 478, 5.SM.5.3
 non-AFOLU emissions 10–11, 151
 projected emissions 195, 196, 196, 198, 199
 soil emissions 134, 192, 193, 398
 sources 160–161
- no-till farming** 292, 376, 383, 471, 686
- non-governmental organisations (NGOs)** 737
- non-local effects** 184–186, 185
- Normalised Difference Vegetation Index**
see NDVI
- normative scenarios** 94
- North America**
 agricultural emissions 159
 BVOC emissions 169
 desertification 265
 dryland areas 255, 257, 265
 dust emissions 167
 floods 744
 historical land cover change effects 172–173, 174
 invasive plants 259, 299
 monsoon rainfall 176
 rangelands 372
- Northern Ireland** 370–371
- novel technologies** 485–486, 513–514
- NOx concentrations** 169, 170
- NPP (net primary production/productivity)** 5, 86, 87, 140, 363–364
 livestock production systems 456
 NDVI as proxy for 363
 of rangelands 456, 457
 relationship with rainfall 363–364
- nutrient depletion** 355
- nutrition** 5.SM.5.1, 7.SM.7.1
- nutrition transition*** 480, 489, 505
- ## O
- oases** 300–302, 300, 302
- obesity/overweight** 5, 6–7, 444, 445, 445, 446, 510
 global trends 444, 445, 446
- ocean acidification*** 627n, 691
- off-site feedbacks** 269
- Okavango Basin** 263, 397
- Oman** 300, 301
- on-the-ground actions**
 addressing desertification 279–283, 280
 addressing land degradation 381–384
- organic agriculture** 566–567

- organic carbon (OC)** 167–168
out-migration 259, 276, 285, 518
over-consumption (of food) 490
over-exploitation of land resources 79
over-extraction of groundwater 271, 289
overarching frameworks 565–566, 566–567, 600
 food security 5.SM.5.5
Owena River Basin 263
ozone (O₃)* 135, 451, 573–574, 691
 BVOC emissions and 169, 170, 192
 pollution management 573–574, 591, 606
- P**
- Pacific region** 255, 517, 518
Pakistan 299–300, 452, 744
palm oil 398, 562, 588, 624, 741
Paris Agreement* 81, 199–201
 cooperation mechanisms 704–705
 food systems in NDCs 449
 global initiatives for food security 473, 474
 performance indicators 725
Parthenium hysterophorus (Congress weed)
 298
participatory governance* 391, 743, 745–746
particulate matter 591
pastoralists/pastoral systems 8, 257, 384
 adaptive capacity 22, 276, 448
 agropastoralists 257, 439, 455–456, 5.SM.5.1
 bush encroachment 282–283
 community-based natural resource
 management 287
 drought and 276, 457–458
 fire management 281–282
 gender and climate change impacts 5.SM.5.1
 grazing management 281–283, 604, 623
 impacts of climate change 276, 455–458,
 5.SM.5.1
 impacts of desertification 276
 institutions based on ILK 747
 land tenure 749, 751
 risks to 276
 traditional practices 284
 vulnerability 257, 439, 454–456, 458
pasture*
 conversion for energy crops 373
 current global extent 85
 dryland areas 254–255
 intensification 562
 intensive 6–7
 N₂O emissions 134, 162
 past and ongoing trends 86, 87
 projected land use change 30–32
 reduction in 196–197, 494
pathways* 16–17, 94, 737
 1.5°C pathway 22–23, 32n, 195–199, 200–201,
 373, 581, 686
 2°C pathway 22, 195, 197–199, 200–201
 3°C pathway 22, 701
 adaptation pathways 104, 721–722, 743
 archetypes 198–199, 198
 climate pathways 641–644
 climate-resilient pathways 678
 defined 93
 future pathways for climate and land use
 641–644
 global emissions 168, 170
 integrated pathways for climate change
 mitigation 195–199
 land pathways 30–32, 641–644
 least cost pathway 195
 linking socioeconomic development, mitigation
 responses and land 30–32
 multiple policy pathways 510
 near-term action 198–199
 policy pathways 640, 742–743
 representative agricultural pathways 460
 sustainable development pathways 678
 see also mitigation pathways; RCPs; SSPs
pathways analysis 94, 95
payment for ecosystem services see PES
payment for environmental services see PES
peatlands* 397–398
 carbon balance 193
 carbon stored in 355, 397, 398
 climate change and 193
 degradation 89, 355, 397–398, 476
 emissions 153, 159–160, 397, 476, 477
 fire 149, 153, 397, 398
 management 159–160, 392, 398
 methane fluxes 159–160
 sustainable management 100
 see also restoration and reduced conversion
 of peatlands
perennial crops 194, 383, 392, 393–395, 485
perennial grains 383, 392, 393–395
performance indicators 725, 742, 743
peri-urban areas* 135, 188, 505, 507
permafrost* 184, 357, 382
 climate feedbacks 183, 184
 release of CO₂ 134, 184
 release of methane (CH₄) 134, 137, 184
 risks due to degradation 681, 684, 689,
 7.SM.7.1
 soil carbon loss 8, 134, 184
 thaw-related ground instability 21, 684
**PES (payment for ecosystem/environmental
 services)** 105, 287, 706–707, 733
pests and diseases 8, 358, 457, 458
phenomics-assisted breeding 513
phosphorus cycle 202–203
PICS (Purdue Improved Crop Storage) 472
planetary boundaries transgression 7.SM.7.1
plant diversity 201, 504
policies 27–29, 80, 640, 695–717, 726
 acceptability 490, 510, 698, 754
 agricultural 286–287, 473, 482, 508, 697,
 701–702, 703, 714
 barriers to implementation 714–717
 for biofuels and bioenergy 738–739
 for climate extremes 699–701, 714
 climate policies 27, 68, 103, 639, 642, 678, 716
 coherence 713–714, 730, 734, 739
 coordination 28, 390, 739
 cost and timing of action 723
 cross-sector policies 104
 customary norms 106
 for decentralised resource management 287
 delayed action and 645
 development 742
 drivers of desertification 259–260
 for economic diversification 288–289
 economic and financial instruments 105–106,
 474, 698, 710–711, 711–713
 effectiveness 699
 enabling environment 508–510, 713–714
 expanded policies 508–510, 509, 5.SM.5.5
 for food security 474, 696–698, 696, 719
 food system policies 27–28, 474, 507–510, 509,
 5.SM.5.5
 forest conservation instruments 709–711
 gender-inclusive approaches 718–719
 health related 28, 510
 for improvement of IWM 305
 incorporating ILK 258
 integration 737–738
 for investment in R&D 287–288
 land tenure 287, 709–711, 719, 751–752, 753
 legal and regulatory instruments 105
 maladaptation 734
 market-based instruments 702, 703
 mitigation policies 27–28, 509, 696, 701–702, 714
 multi-level policy instruments 695–696, 696
 multiple policy pathways 510
 policy and planning scenarios 94
 response to climate-related extremes
 699–701, 714
 response to desertification 258, 285–288
 response to drought 290–291, 714
 response to floods 714, 744
 response to GHG fluxes 701–705, 714
 response to land degradation 27, 387–388,
 396–397, 696, 705–711, 705
 response to land-climate-society interaction
 hazards 688–689
 rights-based instruments 106
 risk management 467–468, 700–701
 in shared socio-economic pathways 641–644
 social and cultural instruments 106
 for social protection 696–697, 698–699, 716
 standards and certification 707–709, 708, 739
 for sustainable development 288–289
 for sustainable land management 27–29, 258,
 285–289, 696, 723
 synergies and trade-offs 725, 726, 730–734
 timescales 695
 windows of opportunity 694–695
policy goals 566
policy lags 645
policy nudges 722
policy pathways 640, 742–743
pollinators 458–459, 606
pollution 357
 see also air pollution
polycentric governance 104, 578, 737, 738,
 5.SM.5.5
population distribution 558, 560
population growth 5, 88, 301, 517, 692
 in SSPs 13, 14, 16

urban areas 186

pore volume loss 354–355

portfolio analysis 721

portfolio response 695

potential evapotranspiration (PET) 276–277

poverty*

- agroforestry adoption 384
- climate change and 259, 279, 691–692
- climate change and food security 446–447
- climate change-poverty linkages 378–379, 379
- and diet 442, 446
- in dryland areas 257, 259, 260, 279
- ecosystem services and 730
- impacts of climate-related land degradation 377–379
- impacts of desertification 259, 272–273, 279
- land degradation-poverty linkages 378–379, 379
- projected 279
- reduction 289
- social protection policies 698–699
- and traditional biomass use 741–742

poverty eradication* 19, 20, 27, 33, 640

power dynamics 638

precautionary principle 723

precipitation

- adaptation technologies 475
- anomalies 451
- and carbon sequestration 271
- change in rainfall patterns 137, 147, 369–370
 - food and livelihood security 516, 518
- dryland areas 258, 262, 265, 271
- enhanced by irrigation 180, 181
- and erosion 361–362, 370–371, 682
- extreme rainfall events 12, 15, 137, 147–148, 302, 361, 369–371, 7.SM.7.1
- extreme snowfall 147
- impact on food security 5.SM.5.2
- impacts of precipitation extremes on different land cover types 147–148
- increased frequency and intensity 7, 137, 147–148, 360–362, 369–371
- intensity 7, 147, 360–362, 369–371
- land cover changes and 174, 175–176, 176
- land cover induced changes 176
- mesoscale convective systems (MCS) 370
- monsoon areas 176, 176
- and net primary production (NPP) 363–364
- non-local and downwind rainfall effects 185–186, 185
- projected 278, 302, 305, 360–362, 370–371
 - monsoon rainfall 175–176, 176
- rainfall patterns and deforestation/forestation 178, 179
- rainfall and SST anomalies 258–259, 266
- Sahel rainfall 258, 377, 450, 451
- snow 147, 178, 179, 183–184, 361
- tropical regions 183
- under different SSPs 7.SM.7.1
- urbanisation 187
- variation and effect on livestock 455
- and vegetation variability 183, 265–266, 361, 451

precision agriculture 100, 503, 566–567

precursors* 139, 166, 167–168, 169, 170

prevalence of undernourishment (PoU) 464

primary biological aerosol particles (PBAP)
see bioaerosols

primary production* 201–202

private net benefits 695

***Prosopis juliflora* (Mesquite)** 298, 299

protected areas 100

public net benefits 695

public policy organisations 105–106

Purdue Improved Crop Storage (PICS) 472

R

radiation

- aerosol interaction 166–167, 168
- aerosol scattering 166, 167–168, 169, 170
- interactions with dust 166–167

radiation absorption, aerosols 166, 167, 168

radiative forcing*

- BVOC emissions and 170
- carbonaceous aerosols and 168
- changes in albedo induced by land use change 138
- direct aerosol effect 169, 170, 192
- dryland areas 270
- dust emissions and 167
- indirect aerosol effect 169, 170, 192
- net positive response to historic land cover change 172

rain use efficiency (RUE) 265, 266, 363–364

rainfall see precipitation

rainwater harvesting (RWH) 280, 281

range expansion 143, 462

rangelands 494, 562, 633

- Badia region, Jordan 302–304
- composition 456
- degradation rate 276
- fire management 281, 282
- floods 744
- grazing practices 281–282, 376
- impact of climate change 372, 454–456
- integrated watershed management (IWM) 302–304
- land tenure-climate change interactions 751
- N₂O emissions 162
- overlapping land challenges 560, 561, 561, 633
- productivity trends 366
- selective grazing 355
- soil compaction reduction 596
- soil erosion 293
- sustainable management 281–282, 284

RAPs (representative agricultural pathways) 460

RCPs (representative concentration pathways)*
92, 93, 680

- combined with SSPs 13, 30–32
- desertification projections 276–277
- forestation impacts 179
- GHG emissions and removals 195–197, 196
- land cover change scenarios 30–32, 173, 174–176, 175, 176
- mitigation scenarios 195–199
- RCP1.9 mitigation pathway 198–199, 198
- RCP2.6 mitigation pathway 198, 198

- SLCF emissions 169

real options analysis 721

recycling 512

REDD+ (Reducing Emissions from Deforestation and Forest Degradation*) 385–386, 388, 704, 709–711

- corruption risk 716
- and land tenure 751, 752

reduced deforestation and forest degradation
385–386, 567, 571

- adaptation potential 590, 590
- combined with bioenergy and BECCS 637
- feasibility 620, 6.SM.6.4.1
- impact on desertification 595–596, 596
- impact on food security 604, 605
- impact on land degradation 600, 600
- impact on NCP 628, 6.SM.6.4.3
- impact on SDGs 631, 6.SM.6.4.3
- mitigation potential 21, 585, 585
- policy instruments 726
- potential across land challenges 610, 612
- potential deployment area 633
- sensitivity to climate change impacts 624

reduced food waste (consumer or retailer)
100–102, 567, 577

- adaptation potential 593, 593
- combined with bioenergy and BECCS 637
- feasibility 622, 6.SM.6.4.1
- impact on desertification 598, 598
- impact on food security 607, 607
- impact on land degradation 602, 602
- impact on NCP 629, 6.SM.6.4.3
- impact on SDGs 632, 6.SM.6.4.3
- mitigation potential 587, 588
- policy instruments 726
- potential across land challenges 609, 610, 615
- sensitivity to climate change impacts 624

reduced grassland conversion to cropland 567, 570, 588–589

- adaptation potential 589
- combined with bioenergy and BECCS 637
- feasibility 619, 6.SM.6.4.1
- impact on desertification 595, 595
- impact on food security 604, 604
- impact on land degradation 599, 600
- impact on NCP 628, 6.SM.6.4.3
- impact on SDGs 631, 6.SM.6.4.3
- mitigation potential 584, 584
- policy instruments 726
- potential across land challenges 610, 611
- potential deployment area 633
- sensitivity to climate change impacts 623

reduced landslides and natural hazards 567, 573, 726

- adaptation potential 591, 592
- feasibility 621, 6.SM.6.4.1
- impact on desertification 597, 597
- impact on food security 606, 606
- impact on land degradation 601, 601
- impact on NCP 628, 6.SM.6.4.3
- impact on SDGs 631, 6.SM.6.4.3
- mitigation potential 586, 587
- policy instruments 726

- potential across land challenges 610, 614
sensitivity to climate change impacts 624
- reduced pollution including acidification** 567, 573–574, 586
adaptation potential 591, 592
combined with bioenergy and BECCS 637
feasibility 621, 6.SM.6.4.1
impact on desertification 597, 597
impact on food security 606, 606
impact on land degradation 600, 601
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 586, 587
policy instruments 726
potential across land challenges 614
sensitivity to climate change impacts 624
- reduced post-harvest losses** 100–101, 567, 577
adaptation potential 593, 593
feasibility 622, 6.SM.6.4.1
impact on desertification 598, 598
impact on food security 607, 607
impact on land degradation 602, 602
impact on NCP 629, 6.SM.6.4.3
impact on SDGs 632, 6.SM.6.4.3
mitigation potential 587, 588
policy instruments 726
potential across land challenges 609, 610, 615
sensitivity to climate change impacts 624
- reduced soil compaction** 567, 573, 596
adaptation potential 591, 591
feasibility 620, 6.SM.6.4.1
impact on desertification 596, 596
impact on food security 605, 606
impact on land degradation 601
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 585, 586
policy instruments 726
potential across land challenges 613
sensitivity to climate change impacts 624
- reduced soil erosion** 280–281, 292–294, 567, 572
adaptation potential 591, 591
feasibility 620, 6.SM.6.4.1
impact on desertification 596, 596
impact on food security 605, 606
impact on land degradation 600, 601
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 585, 586
policy instruments 726
potential across land challenges 613
sensitivity to climate change impacts 624
- reduced soil salinisation** 283, 567, 573
adaptation potential 591, 591
feasibility 620, 6.SM.6.4.1
impact on desertification 596, 596
impact on food security 605, 606
impact on land degradation 600, 601
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 585, 586
policy instruments 726
- potential across land challenges 609, 613
sensitivity to climate change impacts 624
- Reducing Emissions from Deforestation and Forest Degradation*** see REDD+
- reforestation***
case studies 392, 395–397
defined 98
green walls/dams 294–296, 297
implications 98–99
mitigation potential 191
mitigation scenarios 99–100
reducing/reversing land degradation 374–375, 395–397
risk of land degradation 374
side effects and trade-offs 97, 99, 100
water balance 98
- reforestation and forest restoration** 567, 571
adaptation potential 590, 590
adverse side effects 605, 612
best practice 25
combined with bioenergy and BECCS 637
feasibility 620, 6.SM.6.4.1
global potential 25
impact on desertification 596, 596
impact on food security 605, 605
impact on land degradation 600, 600
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 585, 585
policy instruments 726
potential across land challenges 610, 612
potential deployment area 633
sensitivity to climate change impacts 623–624, 624
- regional climate** 12, 47, 53, 94, 107, 139–140, 166, 182–186, 182, 183, 205
impacts of aerosols 166–167, 168, 268, 377
impacts of bioenergy deployment 194
impacts of land cover change 171, 172–174, 174, 175–176, 176, 179, 572
impacts of land degradation 377
- regional climate models (RCMs)** 147, 276–277, 278
- regulatory policy instruments** 105
- remote sensing** 33, 52, 56
assessing desertification 253, 261–262, 263–264
assessing land carbon fluxes 153, 155, 163–164, 165
assessing land degradation 348, 363–364, 365, 367
crop production 452
dust emissions 167, 683
early warning systems 475, 513
estimating CO₂ emissions 153, 163
forest loss 86, 153, 155, 367–368
greening and browning 7, 143–144, 265–266
limitations 7n, 91, 262
mangroves 402
monitoring risks to food security 475, 513
vegetation indices 143–144, 165, 265–266, 558
- renewable energy** 287–288, 289, 709, 735
see also bioenergy
- representative agricultural pathways (RAPs)** 460
- representative concentration pathways** see RCPs
- residual risks** 291
- residual trends** see RESTREND method
- resilience*** 103, 105–106, 388–389
of agriculture 280, 591
aquaculture 471
building via agroecology 499–500
of crop production systems 591
dryland populations 256–258, 284, 285
ecosystem resilience 265
food systems 468, 469, 591
investing in 723
mountain communities 469
pastoral communities 276
socio-ecological 106, 706, 736–737
sustainable food systems 465–466
to climate-related land degradation 378
to extreme climate events 28, 500, 513
to land degradation 388–389
- respiration*** 201–202, 204
- response options** 18–23, 24–26, 96–103, 97
addressing desertification 279–292, 595–599
addressing food security 603–608, 609
addressing land degradation 381–388, 599–603
barriers to 556, 756, 6.SM.6.4.1
climate consequences 135–136, 188–201
community approaches 640
competition for land 18–19, 24–26, 97
demand management 101–102, 190, 191, 195
enabling 103–106, 554, 558, 633
food system 21–22, 449, 492, 493
increased demand for land conversion 19
and land-use change 18–19, 22–23, 25–26, 188
with large land-area need 19, 97
locally appropriate 384–385
mitigation potential 189–193, 190, 194–195
opportunities 756
Paris Agreement and 199–201
reduced demand for land conversion 18–19
regional variation in mitigation benefits 194
risks arising from 686–688
role of ILK 746–747
socio-economic co-benefits 33–34
and sustainable development 18, 627, 630, 631–632, 6.SM.6.4.3
upsizing 33, 554–555, 738, 756
urban 188
see also integrated response options; land management response options; policies; risk management response options; value chain management
- restoration and reduced conversion of coastal wetlands** 400–401, 401, 567, 574
adaptation potential 592, 592
feasibility 621, 6.SM.6.4.1
impact on desertification 597
impact on food security 606, 606
impact on land degradation 601, 601
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 193, 586, 587
policy instruments 726
potential across land challenges 610, 614

- potential deployment area 633
sensitivity to climate change impacts 624
- restoration and reduced conversion of peatlands** 159–160, 398, 557, 567, 574
adaptation potential 592, 592
feasibility 621, 6.SM.6.4.1
impact on desertification 597
impact on food security 606, 606
impact on land degradation 601, 601
impact on NCP 628, 6.SM.6.4.3
impact on SDGs 631, 6.SM.6.4.3
mitigation potential 193, 586, 587
policy instruments 726
potential across land challenges 610, 614
potential deployment area 633
sensitivity to climate change impacts 624
- RESTREND method** 262, 265, 363–364
- reversibility**
impact of delayed action 34, 645
integrated response options 618, 619–623, 6.SM.6.4.1
of trade-offs 730
- Revised Universal Soil Loss Equation (RUSLE)** 364
- rewetting*** 193, 377
- rice cultivation** 384, 452, 476, 477, 584
methane (CH₄) emissions 159, 160, 476, 477
reducing emissions 189
- rights based policy instruments** 106
- Rio Conventions** 387
- risk*** 14, 15–17, 673–692, 678, 7.SM.7.1–3
adaptive governance of 742
categories 680
climate-related 696
current levels 15
definition 91, 679, 680
drought risk mitigation 290–291
fire 148–150
from adverse side-effects 687–688
from changes in land processes 14
from climate change responses 374, 686–688
from disrupted ecosystems and species 691
from land-climate-society hazards 688, 688–689, 732
future risk of desertification 277–278
of hunger 685–686
increasing with warming 14–15, 15
of land degradation from bioenergy and CDR 374
of land degradation under climate change 363
layering approaches 712
of mitigation failure 686–687
monitoring 475
of natural disasters 699
near-term action and 34
policy responses 695–717
reduction initiatives 471
related to bioenergy crop deployment 19, 581–582, 687–688, 687, 7.SM.7.1, 7.SM.7.3
related to drylands water scarcity 16, 684, 685, 7.SM.7.1, 7.SM.7.3
related to food security 16–17, 685–686, 685, 7.SM.7.1, 7.SM.7.3
related to land degradation 684–685, 685, 7.SM.7.1, 7.SM.7.3
SSPs and 16–17, 7.SM.7.1
SSPs and level of climate related risk 684–686, 685
to biodiversity and ecosystem services 691
to communities and infrastructure 691–692
to crop yields 362–363
to humans 691
to land systems from climate change 680–686, 681
to where and how people live 690–692
transitions 14, 680–688, 7.SM.7.1–3
see also decision making
- risk assessment*** 369, 471, 680–688
- risk management*** 67–74, 97, 102, 678, 695
adaptation options 467–468
comprehensive 712, 721, 724
food systems 467–468
land management in terms of 33
policy instruments 105–106, 699–701
proactive 744
- risk management response options** 19, 97, 102, 579–580
adaptation potential 594, 594
delayed action 645
feasibility 618, 623, 6.SM.6.4.1
global potential 24
impact on desertification 598–599, 599
impact on food security 608, 609
impact on land degradation 603, 603
impact on NCP 629, 6.SM.6.4.3
impact on SDGs 632, 6.SM.6.4.3
mitigation potential 588–589, 589
policy instruments 726
potential across land challenges 610, 617
sensitivity to climate change impacts 624
- risk perception*** 515
- risk sharing instruments** 567, 580, 699, 712
adaptation potential 594, 594
feasibility 623, 6.SM.6.4.1
impact on desertification 599, 599
impact on food security 608, 609
impact on land degradation 603, 603
impact on NCP 629, 6.SM.6.4.3
impact on SDGs 632, 6.SM.6.4.3
mitigation potential 588–589, 589
policy instruments 726
potential across land challenges 617
sensitivity to climate change impacts 624
- river basin degradation** 263, 264
- rivers** 697, 731
climate related risks 7.SM.7.1
disruption of flow regimes 688
for transport 735
- riverscapes and riparian fringes** 752
- robust decision making** 721
- RUE** see rain use efficiency (RUE)
- ruminants** 473, 479–480, 487–490, 604
GHG emissions 473, 477, 478, 479–480, 5.SM.5.3
methane (CH₄) emissions 159
transition of land use for 511
see also livestock
- rural areas**
autonomous adaptation 466
benefits of land-based response options 756
climate change and food security 446–447
drought 518
sustainability of rural communities 502
traditional biomass use 740
vulnerability 449
- RUSLE (Revised Universal Soil Loss Equation)** 364
- Russia** 264
- ## S
- safety nets** 459, 510, 697, 698–699, 744
access to UGI 392
- sagebrush ecosystems** 299
- Sahara** 288, 296, 297
- Sahel region** 263, 268, 276, 452
Great Green Wall initiative 296, 297
rainfall 180, 258, 377, 450, 451
- saline soils*** 258, 283
- salinisation** 355, 357
of oasis areas 301
of river basins 263, 264
saltwater intrusion 392, 401–402
- saltwater lakes** 402
- sand aerosols** 268–269, 269
- sand dunes** 265, 277
impact on infrastructure 275
preventing movement 293, 293
stabilisation 283
- sand storms** 268, 283
- satellite observations** see remote sensing
- saturation of integrated response options** 618, 619–623
- Saudi Arabia** 264, 275, 300, 300
- savannah** 86, 265, 270, 562
burning 133, 162, 168
grazing and fire management 281–282, 700
woody encroachment 270, 282–283, 355, 456
- SCC** see social cost of carbon
- scenario analysis** 722
- scenario storyline*** 93, 94
- scenarios*** 34, 88, 93–96
alternative diets in 487–489, 488
baseline scenario 195–196, 197, 564, 565, 684
exploratory scenario analysis 93–94
futures analysis 80, 564
integrated response options in 634, 635
land challenges in 564, 565
land cover changes in 174–176
land-use change 93–96
limitations 95–96
methods and applications 93–95
regional scale 94
uncertainties from unknown futures 92–93
see also mitigation scenarios
- SDG** see Sustainable Development Goals
- sea ice* extent** 174, 179
- sea level rise*** 8, 372
adaptive governance and 743

- climate related risks 7.SM.7.1, 7.SM.7.2
- climate-change-induced 372
- and coastal flooding 592
- and migration 517
- saltwater intrusion 401–402
- socio-economic effects 372
- sea surface temperature (SST)*** 142, 174
 - anomalies and rainfall 258–259, 266
 - changes in 186
 - climate change and 174, 174, 258–259
- sea walls** 402–403
- seasonal variations** 139, 140
- secondary organic aerosols (SOA)** 166, 167, 169, 170
- seed sovereignty** see local seeds
- self-regulation** 106
- semi-arid ecosystems** 271, 595
- semi-natural forests** 560, 561, 561, 562, 633
- Sendai Framework for Disaster Risk Reduction*** 744
- sequestration*** see carbon sequestration
- shared socio-economic pathways** see SSPs
- shock scenarios** 94
- short-lived climate forcers (SLCF)*** 99, 166–170
- short-lived climate pollutants (SLCP)*** 451, 586, 740
- silicate minerals** 374
- silvopasture systems** 504
- sink*** 84
 - of atmospheric CH₄ 159
 - atmospheric hydroxyl radical (OH) sink 158–159
 - capacity 624
 - forest carbon sink 21, 156, 180, 386
 - increasing 157, 165
 - land sink 8–9, 84, 153, 154, 155–157
 - non-anthropogenic land sink 157
 - ocean sink 153, 157
 - see also carbon sink
- Siwa oasis** 301, 302
- SLCF** see short-lived climate forcers
- SLCP** see short-lived climate pollutants
- small hydropower projects (SHPs)** 735
- small islands**
 - coastal degradation 400, 403
 - food security 517, 518
 - Small Island Developing States (SIDS) 193, 400, 403, 473
- smallholders** 593, 608, 697
 - adaptive capacity 22
 - agroecology 499–500
 - climate change impacts 459–460
 - conservation agriculture 500
 - land tenure 749, 750, 751
 - livelihood diversification 594
 - poverty eradication 640
 - risk management 594
- snow accumulation** 361
- snow-albedo feedback** 178, 179, 183–184
- snow melt** 361
- social barriers to adaptation** 715
- social capital** 284, 390
- social cost of carbon (SCC)*** 102, 694, 702
- social-ecological systems (SES)** 104, 556–558, 557
 - resilience 106
 - social learning 639
- social learning*** 639, 745, 749
- social policy instruments** 106
- social protection policies** 696–697, 698–699, 716
- societal transformation*** 512
- socio-cultural barriers** 618, 619–623, 6.SM.6.4.1
- socio-ecological resilience** 706
- socio-economic drivers**
 - desertification 259–260, 684
 - land degradation 359–360, 684–685
 - land-use change 79, 93
- socio-economic pathways** see SSPs
- socio-economic responses** 283–284, 285
- socio-economic systems** 33–34, 272–276, 279
- sodic soils*** 258
- sodification** 357
- soil**
 - biological soil crusts 356, 358
 - carbon 381, 382–383, 398, 584
 - carbon management 189, 382–383, 584
 - carbon uptake 278
 - chemical degradation processes 355, 357
 - CO₂ release from deep soil 203
 - compaction/hardening 357
 - degradation 89, 350, 393–395, 456
 - increased water scarcity 274
 - and urban sprawl 603
 - direct temperature effects 362
 - dryland areas 271
 - enhancing carbon storage 100
 - GHG emissions 476
 - GHG mitigation 483
 - global extent of chemical degradation 597, 600
 - impact of flooding 148
 - indicators of land degradation 364
 - integrated crop-soil-water management 280–281
 - land management response options 97
 - methane (CH₄) uptake 159
 - microbial and mesofaunal composition changes 355–356, 358
 - microbial processes 201, 202–203, 204
 - N₂O emissions 11, 162
 - nutrient depletion 357
 - nutrient dynamics 202–203, 204
 - pore volume loss 354–355
 - processes 201–204
 - productivity 608
 - quality 148
 - regional variation 204
 - response to warming 203–204
 - rewetting 162
 - sustainable land management 100
 - temperature 181
 - see also reduced soil compaction; reduced soil salinisation
- soil-based response options** 100, 192–193, 381, 382–383, 572–573, 610
 - adaptation potential 591, 591, 613
 - feasibility 620, 6.SM.6.4.1
 - impact on desertification 596, 596, 613
 - impact on food security 605, 606, 613
 - impact on land degradation 600–601, 601, 613
 - impact on NCP 628, 6.SM.6.4.3
 - impact on SDGs 631, 6.SM.6.4.3
 - mitigation potential 192–193, 585–586, 586, 613
 - policy instruments 726
 - potential across land challenges 613
 - sensitivity to climate change impacts 624
- soil carbon sequestration (SCS)*** 100, 483, 484, 583–584, 605, 624
 - agroforestry 485, 485
 - impact of desertification 278
 - measures to combat desertification 20
- soil conservation*** 287, 292–294, 382–383
- soil erosion*** 5, 354, 356, 367
 - adaptation limits 21
 - case studies 292–294
 - caused by human activity 293
 - in Central Asia 293–294
 - costs 682
 - cropping methods and 280–281
 - dryland areas 258, 259
 - erosivity of rainfall 370–371
 - field-based data 366
 - hotspots of desertification 292–294, 295
 - impact of climate change 258, 292–294, 360, 361–362, 363, 393
 - impact on GHG 376
 - irrigation and excessive water use 293, 294
 - land sink and 156
 - management and mitigation potential 192
 - observed erosion rates 361–362, 361
 - projected 278
 - rainfall intensity and 258, 361
 - reduction methods 292–294
 - risk due to precipitation changes 370–371
 - risks from climate change 681, 682, 7.SM.7.1
 - RUSLE model 366
 - vegetation cover and 362
 - see also reduced soil erosion; wind erosion
- soil management** 280–281, 382–383, 398–400, 500–501
 - adaptation options 470–471
 - precision agriculture 503
 - short-term static abatement costs 102
 - see also reduced soil compaction; reduced soil salinisation
- soil moisture*** 146, 303, 303, 362
 - climate feedbacks 184
 - soil carbon and 204
- soil organic carbon (SOC)*** 201, 281
 - climate change and 134, 258
 - conservation agriculture 500–501, 584
 - emissions 201
 - land degradation 351, 352, 366
 - land degradation response measures 382–383, 393–395, 397, 398
 - loss 381, 584
 - organic matter inputs by plants 204
 - peatlands 397, 398
 - perennial grains and 383, 392, 393–395
 - permafrost storage 134, 184
 - response to warming 203–204

- sequestration 192, 199
 urbanisation 187
 vertical distribution 203
 see also increased soil organic carbon content
- soil organic matter (SOM)*** 393
 decline 357
 indicators of land degradation/improvement 364
 pool depletion 355
 soil microbial processes and 203, 204
- soil salinity***
 climate change and 258
 combating 283
 sea water intrusion 402
 see also reduced soil salinisation
- soil and water conservation (SWC)** 561–562
 Ethiopian Tigray region croplands 561–562
- solar power** 275, 377, 735
- solar radiation** 177
- Somalia** 518
- South America**
 biome shifts 371
 Cerrados pasture intensification 562
 crop production 452
 desertification 265
 dryland areas 255
 dryland population 257
 monsoon rainfall 176
 soil erosion and no-till farming 292
 sustainable agricultural intensification 481–482
- South Asia** 257, 264, 751
- South Korea** 395–396
- Southeast Asia** 168, 185, 397–398, 472
- species**
 compositional shifts 358
 extinction rates 564
 impact of climate change 8, 7.SM.7.1
 loss 358
 range expansion 143
 see also invasive species
- SR-LULUCF**
see IPCC Special Report on Land Use, Land-Use Change and Forestry
- SR15**
see IPCC Special Report on Global Warming of 1.5°C
- SRCCCL**
see IPCC Special Report on Climate Change and Land
- SRES** *see* IPCC Special Report on Emission Scenarios
- SREX** *see* IPCC Special Report on Extreme Events
- SSPs (shared socio-economic pathways)*** 13, 92–93, 195, 196, 278, 641–644, 680
 land challenges in 564, 565
 land use, prices and risk of hunger 460–462, 461
 land use/cover change 30–32
 mitigation and climate impacts on food security 495–496
 mitigation responses and land 30–32
 risks related to bioenergy crop deployment 19, 687–688, 687, 7.SM.7.1, 7.SM.7.3
 risks related to drylands water scarcity 16, 684, 685, 7.SM.7.1, 7.SM.7.3
 risks related to food security 16–17, 685–686, 685, 7.SM.7.1, 7.SM.7.3
 risks related to land degradation 684–685, 685, 7.SM.7.1, 7.SM.7.3
- stakeholder engagement** 28, 62, 639, 640, 723
- stakeholder involvement** 293, 638–639, 709–710
 decision making 29, 96, 721, 723, 725
 knowledge sharing 288
 participatory planning 43, 94, 640, 720
 valuing ecosystem services 350, 725
- standards** 707–709, 708
- storage, food system** 472
- stranded assets*** 689
- structural transformations** 289
- stylised scenarios** 93–94
- subnational governance** 737, 5.SM.5.5
- subsidence** 354–355, 357, 372, 684
- subsidies** 697, 701, 741
- Sudan** 263, 275, 380
- Sundarbans mangroves** 400
- supply chains** 493, 513
 shortening 195, 491
 sustainability 707–709, 708
 see also management of supply chains
- supply management response options** 100–102, 578–579
 adaptation potential 493, 593, 594
 combined with bioenergy and BECCS 637
 delayed action 645
 feasibility 618, 622, 6.SM.6.4.1
 impact on desertification 598
 impact on food security 607–608, 608
 impact on land degradation 602, 602
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3
 mitigation potential 493, 588, 588
 policy instruments 726
 potential across land challenges 610, 616
 sensitivity to climate change impacts 624
- supply shocks** 514–515, 515
- supply-side adaptation** 470–472
- supply-side issues of land degradation** 379–380
- supply-side mitigation** 480–487
- surface roughness** 139, 177, 377
- surface runoff** 371, 391, 392
- sustainability***
 community-owned solutions 104
 education 512
 food supply 79–80
 gender agency 104–105
 response options to key challenges 96
 standards and certification 707–709, 708
- sustainable adaptation** 743–745
- sustainable agriculture** 381–384, 465–466, 507
- sustainable certification programmes** 602, 707–709
 palm oil 398, 562, 624, 708
- sustainable development (SD)***
 co-benefits of combating desertification 19–20
 consequences of climate-land change 690–695
 contribution of response options 18, 627, 630, 631–632, 6.SM.6.4.3
 gender-inclusive approaches 717–719
 governance for 737–738, 742–743, 754
 knowledge gaps 755
 land tenure-climate change interactions 751–752
 near-term action 34
 risk management and decision making 673–800
- Sustainable Development Goals (SDGs)*** 21, 79, 388, 506, 507
 and bioenergy deployment 7.SM.7.1
 climate change mitigation 97
 desertification and 272
 global scale 731, 732
 governance 5.SM.5.5
 impacts of integrated response options 627, 630, 631–632, 6.SM.6.4.3
 Land Degradation Neutrality (LDN) 705–706, 705
 local and regional scale 730–731, 732
 synergies and trade-offs 506, 507, 730–731, 732
 and traditional biomass use 741
- sustainable development pathways** 678
- sustainable diets** 497–499
- sustainable farming** *see* sustainable agriculture
- sustainable food systems** 465–466
- sustainable forest management (SFM)*** 21, 100, 351–353, 369, 385–387, 566–567, 571, 585
 CO₂ removal (CDR) technologies 386–387
 defined 21*n*, 351
 REDD+ 385–386
- sustainable intensification (of agriculture)*** 481–482, 501–502, 502–505, 566–567, 583, 589
- sustainable land management (SLM)*** 21, 100, 138, 306, 351–353, 381, 404, 625–626
 adaptive governance 743
 addressing desertification 255–256, 279–283
 addressing land degradation 381–384
 adoption of 283–284, 285, 286, 387–388, 390
 barriers to implementation 28, 389–391
 best practice 391, 723
 cross-level integration 738
 decision making 723
 defined 21*n*, 351
 economic assessment 692–694
 farming systems 381, 465
 financing mechanisms 712
 gender-inclusive approach 80, 104–105
 indigenous and local knowledge 381, 747–748
 investment 285, 387, 390, 391
 migration and 259
 near-term actions 33–34
 policies 27–29, 258, 285–289, 696, 723
 resilience considerations 388–389
 soil erosion reduction 294
 women and 717–719
- sustainable soil management** 500–501
- sustainable sourcing** 567, 578
 adaptation potential 593, 594
 feasibility 622, 6.SM.6.4.1
 impact on desertification 598
 impact on food security 607, 608
 impact on land degradation 602, 602
 impact on NCP 629, 6.SM.6.4.3
 impact on SDGs 632, 6.SM.6.4.3

- mitigation potential 588, 588
 - policy instruments 726
 - potential across land challenges 610, 616
 - sensitivity to climate change impacts 624
 - Sweden** 582
 - synergies** 33, 388, 506, 507
 - adaptation, mitigation and food security 448
 - agricultural sector 733
 - between food security and bioenergy 733
 - between integrated response options and SDGs 630
 - between LDN and NDCs 388
 - climate-smart agriculture 500
 - ecosystem services (ES) 730, 731, 731, 735
 - empowering women 29, 448
 - food system 490–491, 492, 493, 513–514
 - forestry sector 733
 - integrated response options 627, 636–637
 - mitigation and adaptation 22, 448, 499–502, 507, 756
 - mitigation strategies 5.SM.5.3
 - policy choices 725
 - policy interactions 733
 - Sustainable Development Goals (SDGs) 730–731, 732
 - synthetic aperture radar (SAR)** 364
 - Syria** 264, 275, 518
- ## T
- taxation** 105, 698, 701, 727
 - carbon tax 68, 498, 510, 702, 714, 753
 - TCRE (transient climate response to cumulative CO₂ emissions)** 243, 243–247
 - technical mitigation potential**
 - crop production 21, 483
 - cropland soil carbon sequestration 483
 - dietary change 21, 487–489, 488
 - food system 21
 - livestock sector 21, 483, 484, 485–486
 - uncertainties 5.SM.5.3
 - technical potential of integrated response options** 609
 - technological barriers** 618, 619–623, 715, 6.SM.6.4.1
 - technology, adopting** 33, 389–391
 - technology transfer*** 33, 698, 704
 - teleconnections*** 184–186, 373, 379
 - telecoupling** 88, 514
 - temperate forest** 149, 179–180, 192, 596
 - temperate regions** 12, 45, 150, 504
 - biochar 605
 - peatlands 397
 - projected impacts 456
 - seasonal climate 173, 174
 - soil erosion 362
 - water use efficiency 144, 165
 - temperature**
 - albedo-induced surface temperature changes 172
 - biogeochemical cooling 179
 - biogeochemical warming 135, 176–177, 179
 - biophysical cooling 172–173, 174–175, 177, 178, 179
 - biophysical warming 172, 174, 175, 177–178, 179, 197
 - changes due to deforestation/forestation 176–180
 - diurnal 178, 179, 180, 186–187
 - effect on soils 203–204, 362
 - extremes 145–147, 174, 176, 186–187
 - increase and BVOC emissions 170
 - increase and crop yields 680–681
 - increase and crops 143, 300–301, 453, 454
 - increase and desertification 276–278
 - increase and food security 5.SM.5.2
 - increase and livestock production 454, 455
 - increase and soil erosion 682
 - interannual growing-season variability 467
 - irrigation effect on 180, 181
 - land cover change impacts 174, 176 and livestock 455, 455, 456
 - local change due to bioenergy crops 194
 - local surface temperature 179–180, 181–182
 - mean global annual surface air temperature 171–173, 172, 173, 175
 - mean surface air temperature 174
 - plant and ecosystem production thermal response 201–202
 - projected 276–278, 362, 363, 373
 - regional changes 84–85
 - sea surface temperature (SST)* 142, 174, 174, 186, 258–259, 266
 - since pre-industrial period 6, 7
 - urban areas 186–187
 - see also global warming; GMST; GSAT; LSAT
 - temperature overshoot*** 675, 686, 701
 - terracing** 383
 - tier* methods** 160, 164
 - timber yield** 352
 - Time Series Segmentation-RESTREND**
 - see TSS-RESTREND
 - tipping points*** 389, 645, 679, 743
 - desertification 265
 - peatlands 62
 - permafrost collapse 684
 - sagebrush ecosystems 299
 - socio-ecological 755
 - Tracking Adaptation** 474
 - trade** 80, 86, 87, 101, 472, 690
 - trade policies** 508
 - trade-offs** 80, 281, 506, 507, 625
 - acceptable levels 403
 - agricultural sector 733
 - barriers to land-based mitigation 756
 - between adaptation and mitigation 103
 - between ecosystem services 730
 - between integrated response options and SDGs 630
 - CDR and bioenergy 492, 494, 739
 - conservation agriculture 501
 - conventional and cultured meat 487
 - food security 492, 494
 - food system 513–514
 - forest management 191, 352, 368, 733
 - green energy with biodiversity and ES 735
 - integrated response options 627
 - land use intensity and long-term sustainability 504
 - land use/management decisions 350, 353
 - land-based mitigation 733
 - mitigation strategies 5.SM.5.3
 - policy choices 28–29, 725
 - policy interactions 733
 - renewable energy 735
 - socio-economic 97
 - in Sustainable Development Goals (SDGs) 730–731, 732
 - traditional biomass** 20, 288, 375, 709, 740–742
 - transformation***
 - in governance 737, 743
 - societal 512
 - transformational adaptation*** 360, 466–467, 466, 467, 717
 - transformational change** 21, 385, 390, 449, 743
 - transformative change*** 465–466, 749
 - transitions*** 390–391, 511
 - risk 14, 680–688, 7.SM.7.1–3
 - transnational governance** 737
 - transport** 471–472
 - GHG emissions 478–479
 - infrastructure 275, 379–380, 472
 - waterways 735
 - tree mortality** 202, 371–372, 7.SM.7.1
 - treeline migration** 172, 182
 - tropical cyclones*** 372, 392, 400–401, 518
 - climate related risks 7.SM.7.1
 - early warning systems (EWS) 594
 - impact on food security 5.SM.5.2
 - tropical regions** 15
 - BVOC emissions 169
 - crop yields 680–681, 681, 7.SM.7.1
 - deforestation/forestation 149, 177–178, 177, 179–180, 185, 191
 - forest restoration and resilience 562
 - land cover change and climate feedbacks 12, 175, 177–178, 177, 179–180
 - peatlands 397, 398
 - vegetation greening/browning 183
 - troposphere***, ozone in 170
 - TSS-RESTREND** 266, 267
 - Tunisia** 300, 300, 301
 - Turkey** 264, 292–293, 293
 - Tuvalu** 403, 517
- ## U
- UGI** see urban green infrastructure
 - UHI** see urban heat island
 - uncertainty*** 91
 - adaptive governance 742–743
 - adaptive management and 724
 - assessing desertification 255
 - assessing risks of land degradation 369
 - from bioenergy and CDR 374
 - contributing factors 89
 - costs of mitigation 102
 - dealing with 91–93, 96
 - in decision making 96
 - decision making under 693, 719, 721–723, 722

- demand-side mitigation potential 489–490, 5.SM.5.3
- drivers of land use 88
- Earth system models (ESMs) 201–202
- futures analysis 93, 94
- knowledge gaps and 305–306, 403–404
- model parameters 94
- in models 80, 92–93
- in observations 91–92
- plant and soil processes 201, 202
- projecting land-climate interactions 201–203
- unknown futures 92–93
- undernourishment** 5, 442, 605
- risk of under different SSPs 495, 7.SM.7.1
- underweight, global trends** 444, 445, 446
- UNEP Emissions Gap Report** 201
- United Nations Convention to Combat Desertification (UNCCD)***
- definition of land degradation 350
- report 83
- United Nations Framework Convention on Climate Change (UNFCCC)*** 473, 701, 704
- United States of America** 265
- biofuel modelling studies 194
- dust emissions 167
- invasive plants 299
- mesoscale convective systems (MCS) 370
- United States Environmental Protection Agency (USEPA)** 160
- unprecedented climatic conditions** 15
- unused land** 85, 86
- uptake*** 79, 278, 386
- CH₄ in upland soils 159
- enhanced by CO₂ fertilisation 165
- global terrestrial carbon uptake 586, 596
- urban agriculture***
- see urban and peri-urban agriculture*
- urban areas** 17, 86, 186–188, 563
- adaptation 706–707
- aerosols 166, 168
- carbonaceous aerosols 168
- climate change and food security 447
- diets 505
- food forests 578
- food security 188, 449, 505, 507, 607
- increased heat 186–187, 505, 563
- infrastructure 188, 391–393, 392, 563
- land tenure-climate change interactions 752
- maintaining forest cover 590
- mitigation strategies 505, 706
- pollution 187–188, 603, 691
- soil degradation 603
- surface runoff 391, 392
- traditional biomass use 740
- urban planning 186
- urban sprawl 505, 507
- urbanisation 86, 88, 391
- and climate change 186–188, 285
- economic transformations 289
- vulnerability 706
- zoning 706
- see also enhanced urban food systems; management of urban sprawl
- urban green infrastructure (UGI)*** 188, 391–393, 392, 563
- urban heat island (UHI)** 186–187, 505, 563
- urban and peri-urban agriculture*** 505, 507, 563, 608
- V**
- Vallerani system** 303, 303
- value chain management** 19, 97, 100–102, 566, 567, 577–579
- adaptation effects 593, 594
- barriers 618, 6.SM.6.4.1
- delayed action 645
- demand-side
- see demand management response options
- feasibility 618, 622, 6.SM.6.4.1
- global potential 24
- impact on desertification 598
- impact on food security 607–608
- impact on land degradation 602
- impact on NCP 629, 6.SM.6.4.3
- impact on SDGs 632, 6.SM.6.4.3
- mitigation potential 587–588
- policy instruments 726
- potential across land challenges 610, 615–616
- sensitivity to climate change impacts 624
- supply-side
- see supply management response options
- value to society** 692
- Vanuatu** 517
- vegan diet** 487, 488
- vegetation**
- acclimation 201–202
- assessing changes in 261–262
- bioaerosol emissions 168
- biophysical climate interactions 139
- clearing processes 355
- cover change 7.SM.7.1
- albedo impacts 377
- changing rainfall regimes 361
- climate feedbacks 270, 377
- climate induced 258, 259, 369–370, 371–372
- drivers of 265–268, 267
- due to land use 84
- degradation 681, 683, 7.SM.7.1
- drought response 202
- drylands 281–282
- GHG flux 201, 270
- impacts on monsoon rains 183
- increasing CO₂ and 463
- inherent interannual variability 363
- invasive plants 259, 270
- Karapınar wind erosion area 293, 293
- photosynthetic activity 143–144
- plant biodiversity 271–272
- protection against erosion 362
- re-vegetation of saline land 283
- restoration 162, 293
- risks to in dryland areas 684, 685
- Sahel vegetation dynamics 258
- SOM inputs 204
- spatial mosaic 371
- stressors 363
- thermal response of plant respiration 201–202
- trends 365
- variability with rainfall 265–266, 361, 451
- vegetation browning*** 7, 133, 143, 144, 183
- vegetation greening*** 7, 143–144, 261–262, 363, 365
- Africa 263
- Asia 263
- Australia 264
- boreal regions 172
- climate feedbacks 172
- global trends 133
- tropical regions 183
- vegetation optical depth (VOD)** 262, 265, 364
- villages**
- climate smart villages (CSV) 563
- deployment of response options 633, 633
- overlapping land challenges 560, 561, 561, 563
- visions** 94, 95, 96
- VOD** see vegetation optical depth (VOD)
- Volta River basin** 263
- voluntary agreements** 106
- voluntary carbon market** 385, 386, 388
- vulnerability*** 16, 103, 557, 688, 688–689, 745
- access to land-based resources 104
- in agriculture 5.SM.5.2
- livestock production systems 454–455
- pastoral systems 439, 454–456, 458
- production/crop yields 464
- smallholder farmers 459–460
- in aquaculture and fisheries 459, 5.SM.5.2
- and delayed action 644–645
- differential 718
- dryland populations 16, 256–258, 272, 277–278, 452
- of ecosystems to irreversibility 645
- gender and 446, 447–448, 717
- global food system 682
- and land tenure 751–752
- of oases 301–302
- prediction and assessment 288
- reduction via microfinance 475
- rural areas 449
- of soils 591
- to climate-related extremes 138
- to climate-related land degradation 16, 378
- to desertification 16, 277–278
- to drought 464
- to flood 744
- to price volatility 593
- urban areas 706
- vulnerable groups adaptive capacity** 104, 518, 691
- W**
- waste burning** 160
- water**
- for bioenergy 7.SM.7.1
- biomass water content 262

- climate change impacts on resources 205
 - conservation 383
 - contaminated 462–463
 - demand 98, 301, 304, 731
 - drinking water 301, 402
 - for food production 450
 - forest area increase and water balance 98
 - future scenarios of water stress 564, 565
 - groundwater irrigation 734
 - harvesting systems 284, 303, 304
 - impacts of desertification on water use 274
 - integrated crop-soil-water management 280–281
 - land-based water cycle changes 137
 - oasis agriculture and 301
 - transport through soil-plant-atmosphere continuum 202
 - water use trade-offs 733–734
 - water erosion** 295, 356
 - climate related risks 7.SM.7.1
 - direct measurements of 361–362
 - precipitation changes and 370–371
 - water management** 291, 294, 471
 - see also* integrated water management
 - water policy** 717
 - water quality** 558, 559, 560
 - water rights** 749, 750
 - water scarcity** 681, 682–683, 684, 685, 692
 - adaptation measures 686
 - climate related risks 7.SM.7.1
 - impacts of desertification 274
 - under different SSPs 16, 7.SM.7.1
 - water security** 731
 - water stress** 564, 565, 595, 7.SM.7.1
 - water use efficiency (WUE)** 165, 595
 - water vapour** 185–186, 202
 - water-soluble organic compounds (WSOC)** 168
 - waterlogging** 355, 358
 - well-being*** 5, 79, 81, 625
 - consequences of climate-land change 690–695
 - negative impacts of fire 683
 - negative impacts of forest dieback 683
 - Western North Pacific, monsoon rainfall** 176
 - wetlands*** 86, 358, 633
 - carbon balance 193
 - coastal wetland management 400–401
 - drainage for agriculture 89
 - dryland areas 256
 - GHG release 376–377
 - loss of 354
 - methane (CH₄) emissions 157–158, 159
 - mitigation potential of protection and restoration 193
 - restoration 401, 401
 - and sea level rise 372
 - wild forests** 633
 - overlapping land challenges 560, 561, 561
 - wildfires** 133, 148–150, 259, 299, 372, 685, 7.SM.7.1
 - damage 606, 681, 683–684
 - see also* fire; fire management
 - wind energy** 275, 735
 - wind erosion** 271, 294, 356, 362, 595, 600
 - Central Asian drylands 293
 - climate change and 277
 - climate related risks 7.SM.7.1
 - Green Dam regions, Algeria 295
 - prevention and mitigation in Karapinar, Turkey 292–293, 293
 - windows of opportunity** 694–695, 756
 - women** 447–448, 717–719
 - access to resources 104–105
 - adaptive capacity 353, 448, 716, 717
 - empowering 29, 70, 286, 448, 488, 639, 718–719, 719
 - inequality in land use and management 353
 - role in response option implementation 639
 - traditional knowledge 747
 - vulnerability 456, 717
 - woody biomass** 582, 637
 - woody encroachment** 270, 355, 358, 456
 - clearance 280, 282–283
 - wildlife biodiversity 272
 - see also* invasive species/encroachment management
 - World Atlas of Desertification** 256, 365
- ## Z
- zero tillage** *see* no-till farming
 - Zimbabwe, smallholder farmers** 459
 - zoning ordinances** 706