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Environmental systems and societies
Standard level
Paper 1 – resource booklet

27 October 2023

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

1 hour

Instructions to candidates

- Do not open this booklet until instructed to do so.
- This booklet contains all the resources to answer paper 1.

Figure 1(a): Map showing the location of the United States of America (USA)

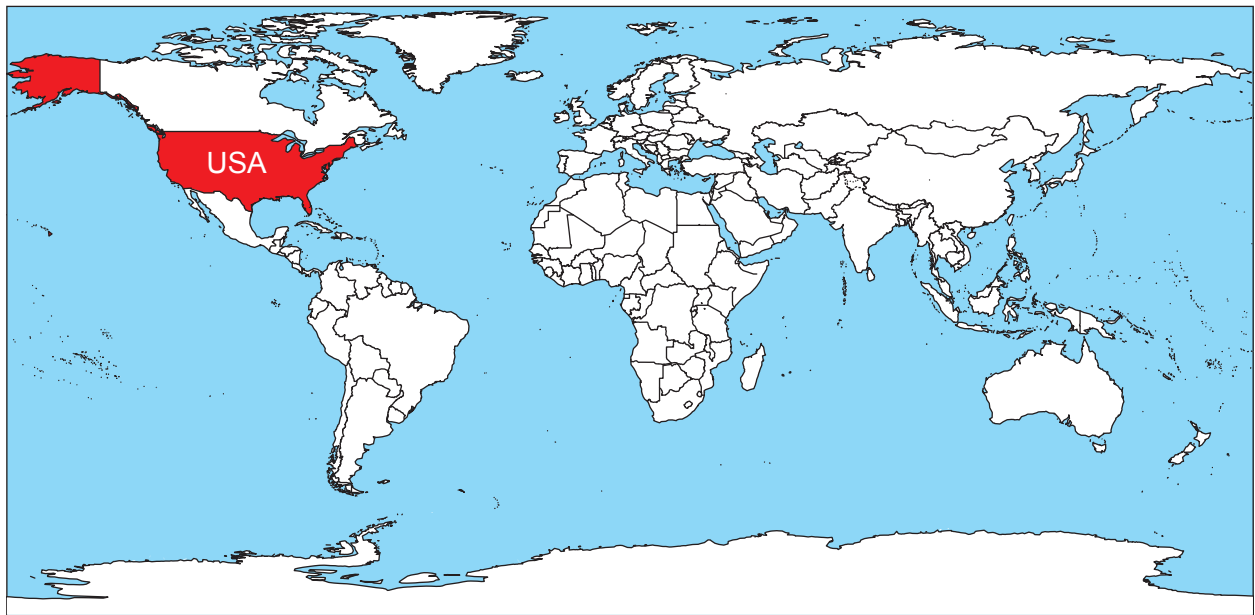


Figure 1(b): Map showing the location of the state of California, USA



Figure 2(a): Fact file on California

- California has the largest state population in the USA: 39 538 223 people (2020 census).
- Its population is growing by natural increase and immigration by 0.61 % per year.
- It is the most productive agricultural state. It produces 25 % of the USA's food.
- Approximately 8 % of people in California are vegetarian.
- Sea levels have risen by 180 mm since 1900.
- The annual average temperature has increased by 1°C since 1895, with 11 of the 20 warmest years occurring between 2000 and 2019.
- By 2035, all new cars sold in California will be 100 % zero carbon emission.

Figure 2(b): Map of California with climate graphs from Crescent City and Desert Center

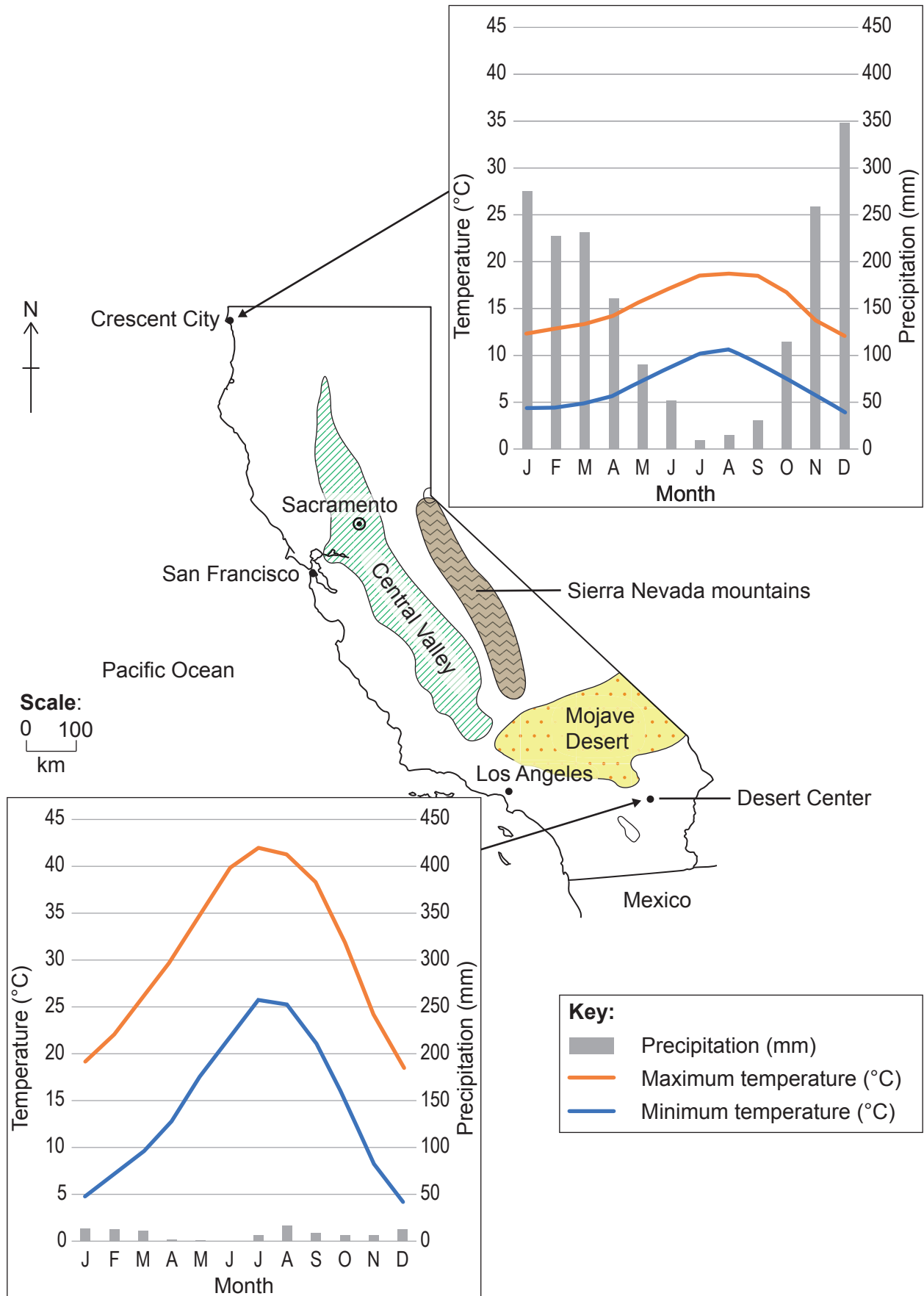


Figure 2(c): Simplified vegetation map of California

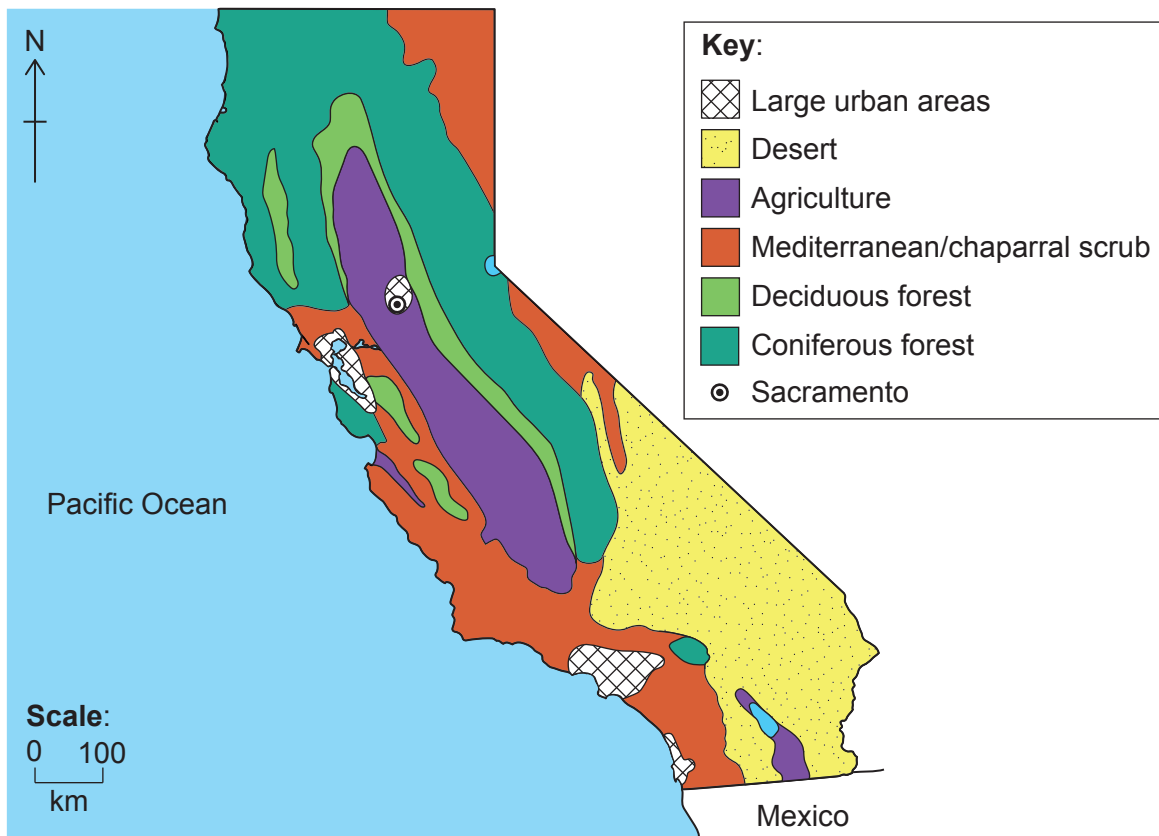


Figure 3: Some of the trees found in the forests of California



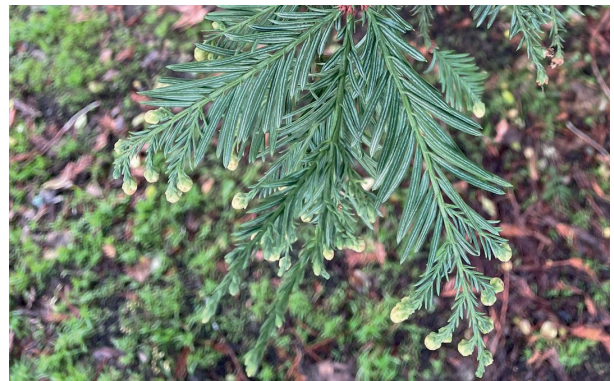
Sitka spruce (*Picea sitchensis*)



Giant sequoia (*Sequoiadendron giganteum*)



Western hemlock (*Tsuga heterophylla*)



Coast redwood (*Sequoia sempervirens*)

Figure 4(a): Fact file on giant sequoia (*Sequoiadendron giganteum*) trees

- They are legally protected in California.
- They are adapted to periodic fire. Historically, wildfires have occurred in California every 6–35 years.
- They have thick bark (up to 46 cm thick) to protect the core of the tree from fire.
- The heat of a fire dries the cones, releasing the seeds. Ash from fires creates nutrient-rich soils for these seeds.
- The seeds can also be released by the long-horned beetle (*Phymatodes nitidus*), which lays its eggs in the cones. When the larvae hatch, they eat the cone, releasing the seeds.

Figure 4(b): Giant sequoia (*Sequoiadendron giganteum*) cones containing seeds



Figure 4(c): Long-horned beetle (*Phymatodes nitidus*)



Figure 4(d): Geographic distribution of giant sequoia (*Sequoiadendron giganteum*) trees in California



Figure 5(a): A wildfire in 2021, which burned an area of 3898 km² over a period of 103 days



Figure 5(b): Number of individual wildfire events and total area burnt in California, 2013–2020

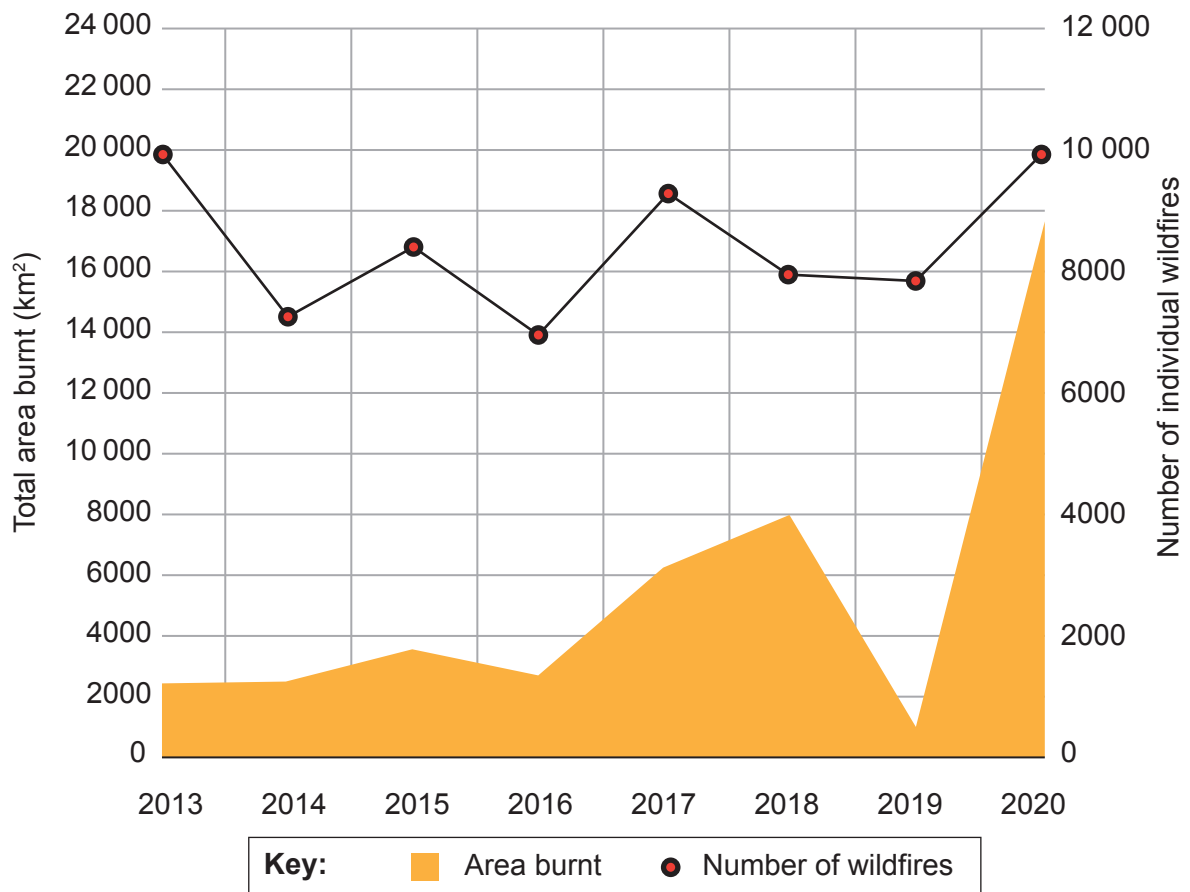


Figure 5(c): Management of wildfires

Actions taken in California include:

- conducting environmental assessments on new developments to prevent additional fire risk
- running public awareness campaigns, e.g. the *One Less Spark* programme
- electricity companies:
 - cutting power to homes during strong winds to reduce the risk of overhead cables sparking a fire
 - agreeing to bury over 16 000 km of electricity cables in 2021.

Figure 5(d): A public awareness poster

Removed for copyright reasons

Figure 6(a): Fact file on water in California

- California experiences periodic drought.
- 80 % of California's freshwater comes from melted snow in the Sierra Nevada mountains.
- Rivers, canals and pipelines are used to transfer water between reservoirs in the Sierra Nevada mountains and the Central Valley and southern California. Some of these transfers are powered by electricity.
- Minimum water flows are maintained in designated rivers to protect fish and endangered species.

Figure 6(b): Water use by region in California, 1998–2015

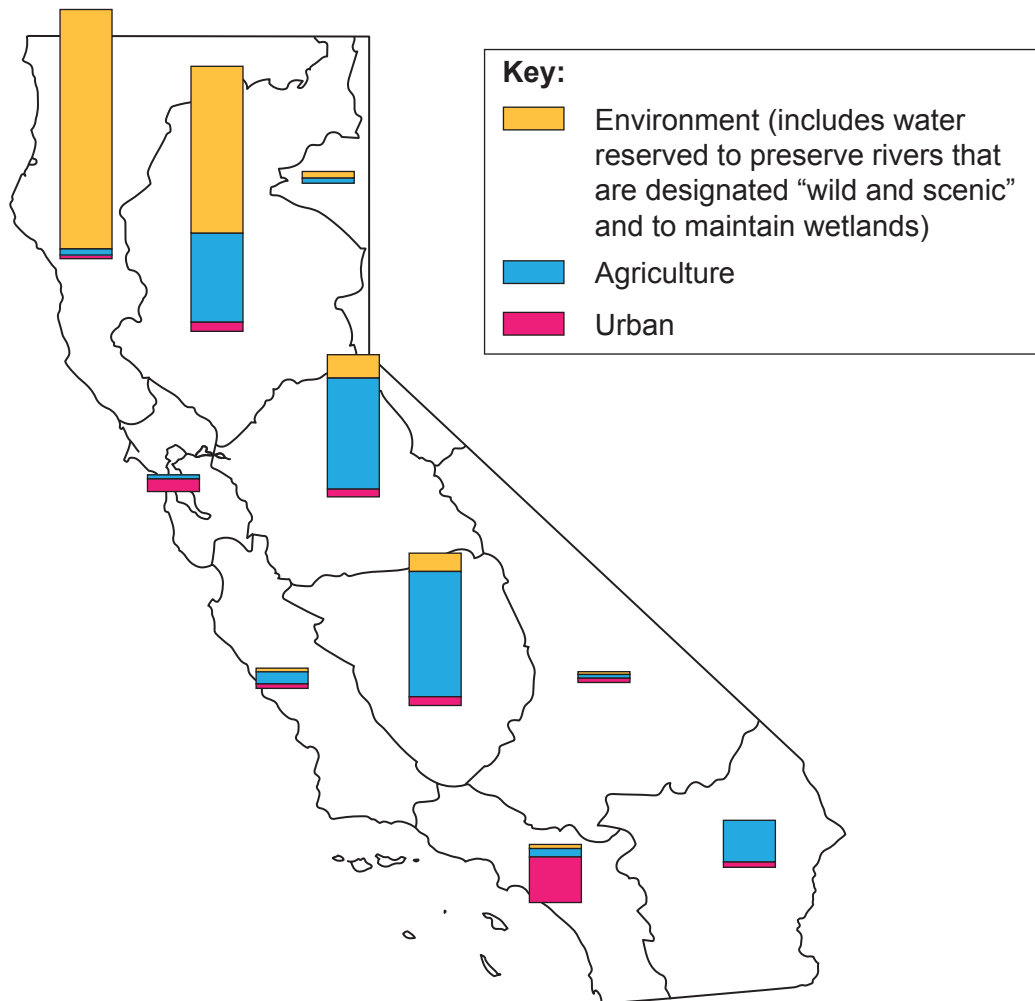


Figure 6(c): Mean daily water use (in litres) per person in California

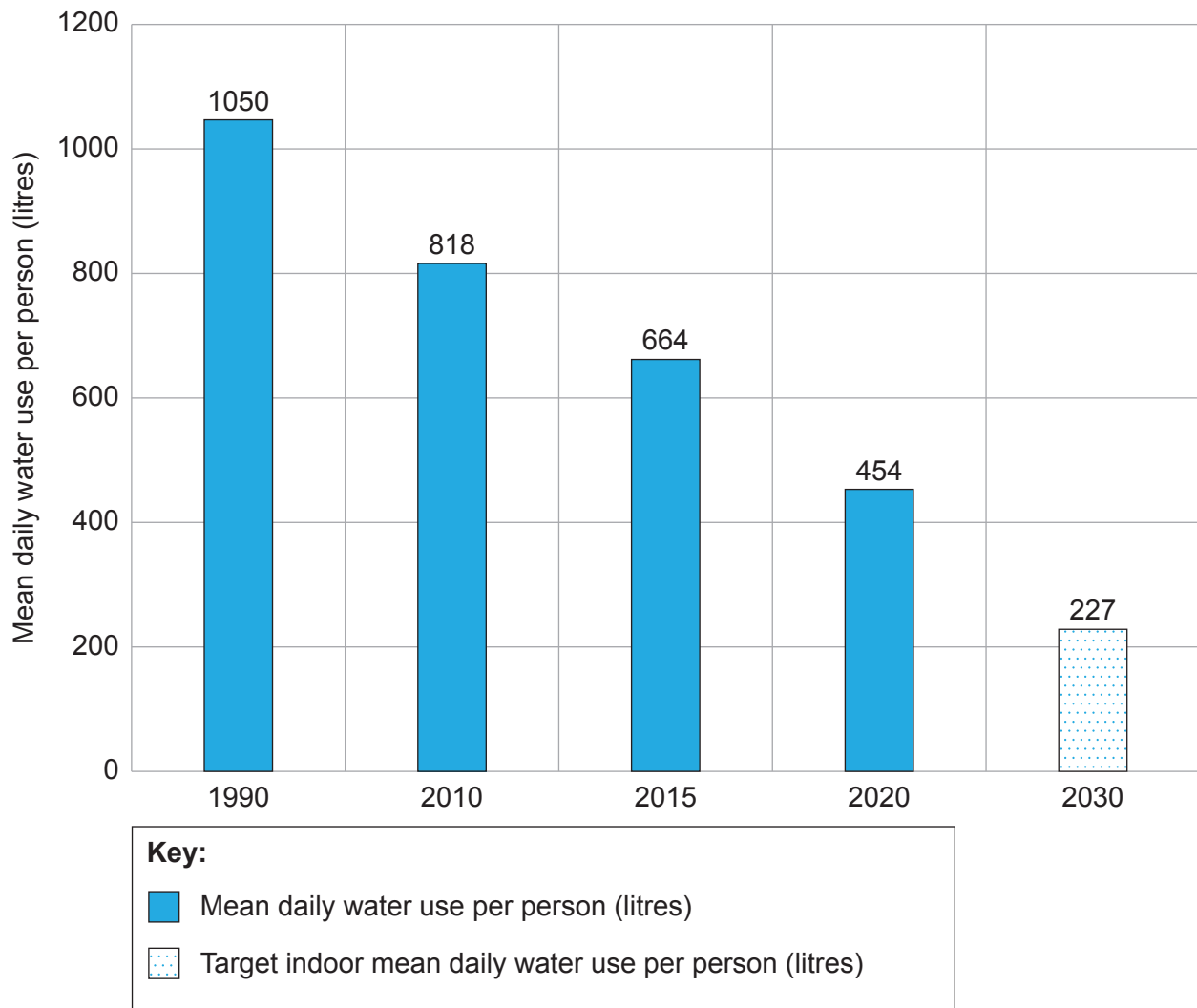


Figure 7(a): Fact file on agriculture in California

- Over 36 000 km² of agricultural land is irrigated.
- In times of severe drought, farmers in the Central Valley receive no water from the state for irrigation.
- Over 50 % of irrigated land is impacted by salinity.
- California produces 81 % of the world's almonds.
 - Almonds are California's most economically valuable agricultural export.
 - The water footprint of one almond is 12 litres.
 - Studies of almond samples have found up to nine different pesticide residues, some of which are toxic to bees.

Figure 7(b): The impact of increasing irrigation water salinity on crop yield potential

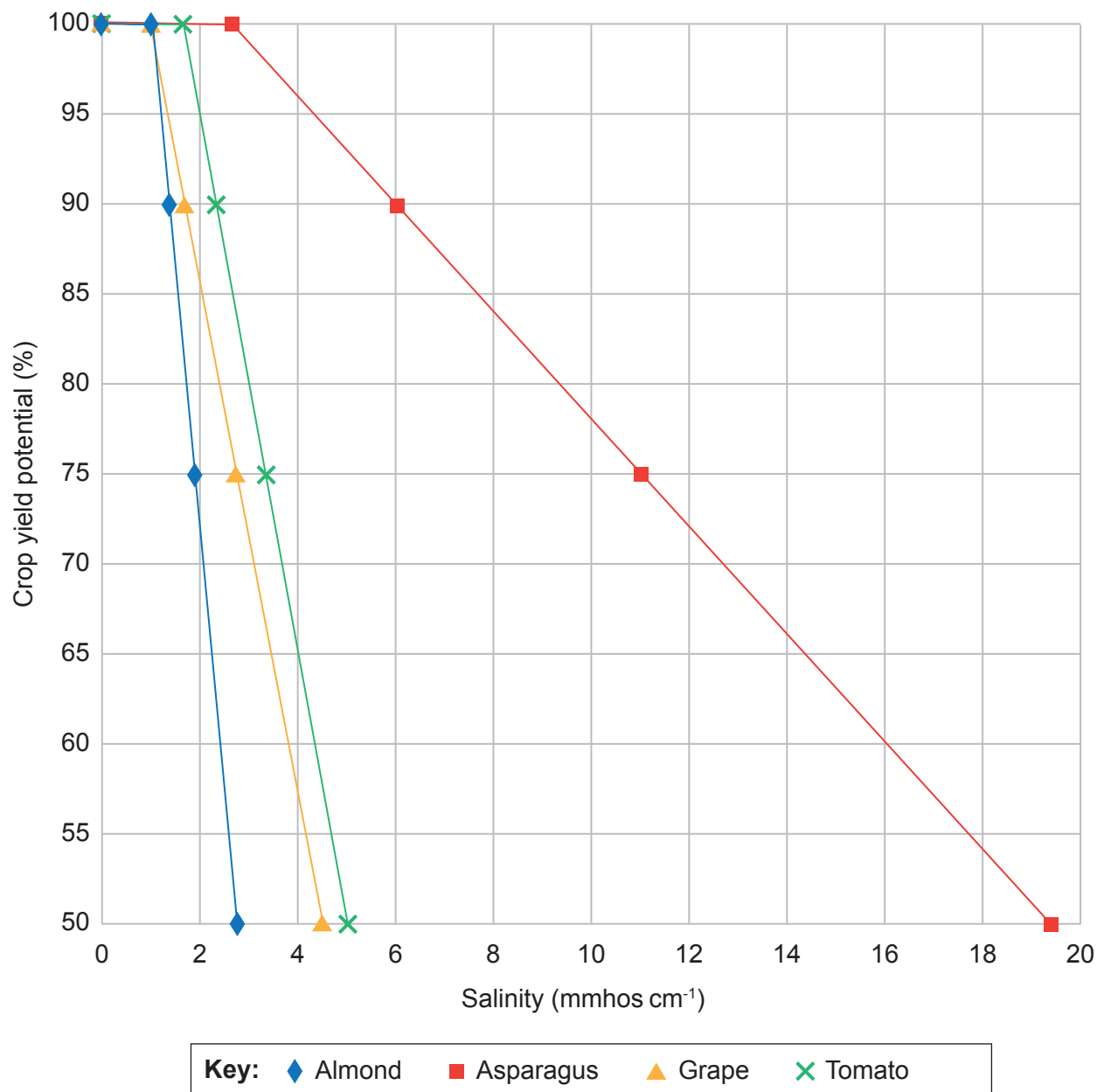


Figure 8(a): Fact file on electricity generation in California

- Water pumping and distribution is the largest single consumer of electricity.
- In 2019, California was the top producer of electricity from renewable sources in the USA.
- California imports 28 % of its electricity from other states and Mexico.
- California has an action plan to:
 - produce 100 % carbon-free electricity by 2045
 - reduce greenhouse gas emissions to 80 % below 1990 levels by 2050.

Figure 8(b): California's net electricity generation by source, April 2021

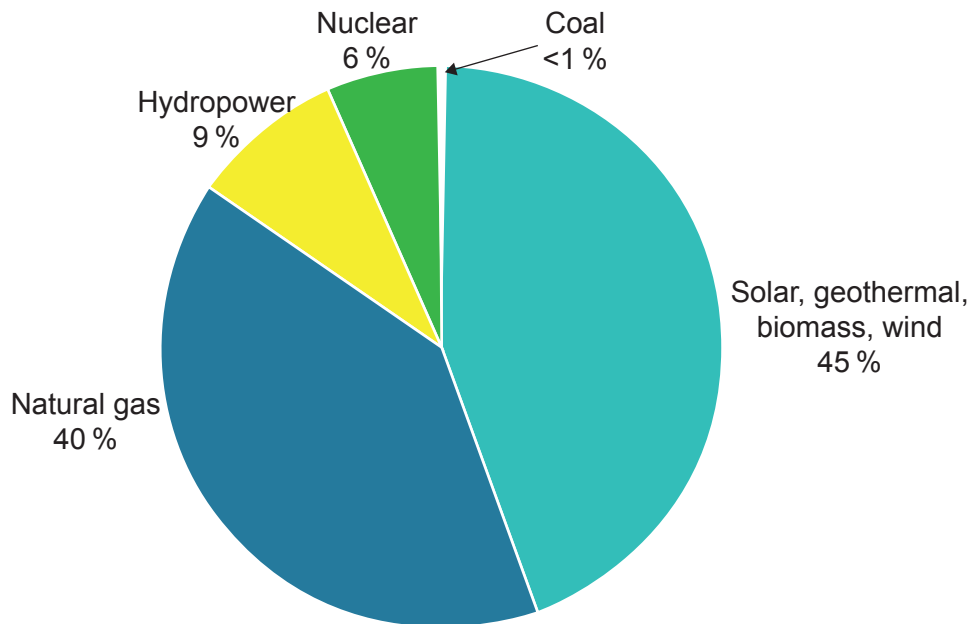


Figure 8(c): The Ivanpah Solar Thermal Plant and Desert Sunlight Solar Farm cover an area of 29 km² in southern California



Figure 8(d): In 2021, the Oroville hydropower station had to be shut down due to extremely low water levels



[Source: Bloomberg Creative / Getty Images]

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References:

- Figure 2(c)** Data Basin, 2011. National Land Cover Database 2006 (U.S.) – zone 12. [online] Available at: <https://databasin.org/datasets/4dd16e120e2540a999566852f503473f/> [Accessed 27 January 2022]. Licensed under a Creative Commons Attribution 3.0 License <https://creativecommons.org/licenses/by/3.0/>. Source redrawn and simplified.
- Figure 3** [images of coast redwood and giant sequoia] © 2022 Jana Lesko.
[images of sitka spruce and western hemlock] © 2022 Sharon Cooper.
- Figure 4(b)** Thereidshome, 2008. *Immature seed (female) cones of Sequoiadendron giganteum, Portland, Oregon, October*. [online] Available at: <https://commons.wikimedia.org/wiki/File:GreenSeedConesSequoiadendronGiganteum.JPG> [Accessed 27 January 2022].
- Figure 4(c)** Junkyardsparkle, 2016. *Longhorn beetle Phymatodes nitidus covered in pollen near Lake Isabella, California*. [online] Available at: [https://commons.wikimedia.org/wiki/File:Phymatodes_nitidus_Kern_county_2016-05-31_\(1\).jpg](https://commons.wikimedia.org/wiki/File:Phymatodes_nitidus_Kern_county_2016-05-31_(1).jpg) [Accessed 27 January 2022].
- Figure 4(d)** Distribution map for *Sequoia sempervirens* (coast redwood) and *Sequoiadendron giganteum* (giant sequoia). https://commons.wikimedia.org/wiki/File:Sequoia_Sequiadendron_range_map.png. Public domain image. Source adapted.
- Figure 5(a)** Photo by Josh Edelson.
- Figure 5(b)** Cal Fire, n.d. Incident Archive (2013–2020). [online] Available at: <https://www.fire.ca.gov/incidents/2020/> [Accessed 27 January 2022]. Source adapted.
- Figure 6(b)** Hanak, E. and Mount, J., n.d. Water use in California. Fact sheet May 2019. [online] Available at: <https://www.ppic.org/publication/water-use-in-california/> [Accessed 1 February 2022].
- Figure 7(b)** Grattan, S. R., n.d. Irrigation water salinity and crop production. [pdf] Available at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/Islands/II_8.pdf [Accessed 16 February 2022]. Source adapted. © 2002 Regents of the University of California. Used by Permission.
- Figure 8(b)** U.S. Energy Information Administration, 2021. *California - state energy profile analysis*. [online] Available at: <https://www.eia.gov/state/analysis.php?sid=CA> [Accessed 16 February 2022]. Source adapted.
- Figure 8(c)** Searls, D., 2019. The Ivanpah Solar Power Facility. Flickr [online] Available at: www.flickr.com/photos/docsearls/50070305888/in/album-72157714987699457/ [Accessed 16 February 2022]. Under Creative Commons licence CC BY 2.0 DEED <https://creativecommons.org/licenses/by/2.0/>.
- Figure 8(d)** Bloomberg Creative / Getty Images.

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