第九讲　图表制作方法

图表是科学论文写作中不可或缺的表达方式。研究结果的叙述一般要结合图(figure)和表(table)展开。图表通过更加简洁、清晰和准确的方式展示和反映作者的意图、想法、数据等诸多内容,可以帮助读者把握整体研究过程、启发思考研究的过程、审视和了解数据的本质,以及分析数据揭示的规律等。简言之,以较小的空间承载更多的信息和以简明的方式反映出特征或规律。

一般而言,审稿人在审阅论文具体内容时,对图表所投入的关注会大于具体文字。一个规范整洁、信息量充足的图表无疑会给文章增色不少。到底选用什么类型的图表传递关键信息、图表中的数据如何取舍、如何绘制规范合理并且优美的图表等,都是初学者在科学论文写作过程中需要掌握的基本要领。本讲结合案例,介绍常见图表类型。在此基础上,结合经典案例就图表绘制进行讲述。

第一节　常见图表类型

在科学论文撰写过程中,通过绘制正确、规范、清晰、美观的图表,把研究内容和结果形象、直观地呈现出来,避免冗长的文字表达是至关重要的。对于具体选用什么样的图表首先要遵循的是目标期刊要求,其次是在规范、合理的基础上自由选择。

一、常见表格类型

(一)三线表

科学论文中表格一般采用三线表(three-line form),有些期刊也会用卡线表(card line table)。卡线表是指,通过表线分割纵向和横向,形成众多数值方框的表格类型。三线表是指,卡线表去掉纵线和表身内横线,只保留顶线、底线和栏目线三条线,形成的表格类型。其中,顶线和底线为粗实线,栏目线为细实线,必要时可以为短栏目添加辅助线。例如在 *Spatio-temporal evolution scenarios and the coupling analysis ofecosystem services with land use change in China*[①] 中,作者通过采用三线表(图 9-1)展示了四种情境下不同土地利用类型敏感性系数的变化值。

(二)表格基本构成要素

一般而言,表格的基本组成要素包括:表序、表题、顶线、底线、栏目线、项目栏、表体、表注等(图 9-2)。在具体使用过程中应结合目标期刊的基本要求,做到表序准确、表题精炼、项目栏

① Sun Y S, Liu S L, Dong Y H, et al. Spatio-temporal evolution scenarios and the coupling analysis ofecosystem services with land use change in China. Science of the Total Environment, 2019(681):211-225.

Table2
Changes in sensitivity coefficient of different land use types under four scensrios.

Scenarios		Land cover types					
		Water	Forest	Grassland	Urban	Barren	Farmland
Ⅰ	2010	0.020	0.526	0.981	0.025	0.690	–
	2050	0.018	0.583	0.958	0.048	0.582	–
	2100	0.014	0.686	0.704	0.037	0.364	–
Ⅱ	2010	0.020	0.526	0.912	0.025	0.690	–
	2050	0.023	0.576	0.998	0.142	0.779	–
	2100	0.027	0.521	0.475	0.215	0.734	–
Ⅲ	2010	0.020	0.526	0.960	0.025	0.690	–
	2050	0.017	0.609	0.877	0.039	0.539	–
	2100	0.013	0.689	0.681	0.031	0.369	–
Ⅳ	2010	0.020	0.526	0.981	0.025	0.690	–
	2050	0.019	0.536	0.901	0.037	0.634	–
	2100	0.021	0.506	0.979	0.042	0.603	–

Adjustment quantity:±50%.

图 9-1　三线表案例示意图

内容具有逻辑性、表身数据内容与正文对应一致。

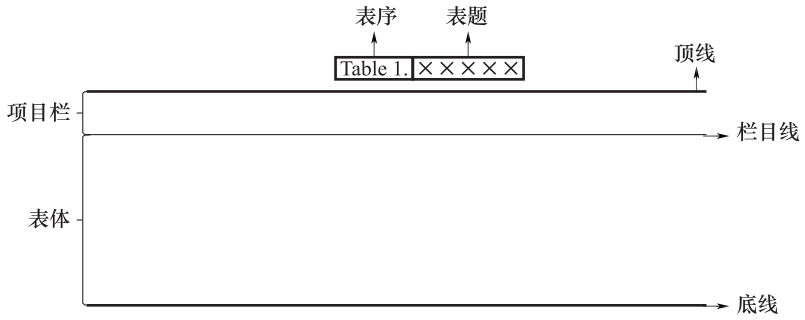


图 9-2　三线表构成要素示意图

二、常见插图类型

图是作者根据研究结果设计并绘制出来的，把事物与事物之间的关系、量与量之间的关系，以及事物的形貌、结构、性质、变化规律等描述得更加直观明了，便于解读的形象化语言，是读者领会研究内容主旨、掌握研究核心要点的关键。下面是一些期刊文献中的插图，供初学者了解熟悉。

（一）统计图

1. 散点图（Scatter Plot），可以展示数据的分布和聚合情况，多用于数据点数量比较大的情况。图 9-3 中，作者选用散点图用来反映群体密度与各生态系统服务指标之间的相关关系。读者在阅读过程中，通过比较数据，可以对数据的内在逻辑关系及变化趋势等形成初步判断。

2. 折线图（Line Chart），多用于反映数据变化趋势，以及不同变化趋势之间关系等情景。如图 9-4 中，作者通过采用折线图，将 21 世纪五种不同土地扩张情景下的全球城市土地总量变化趋势可视化表达，便于直观形象的把握不同情景下变化的趋势与幅度。

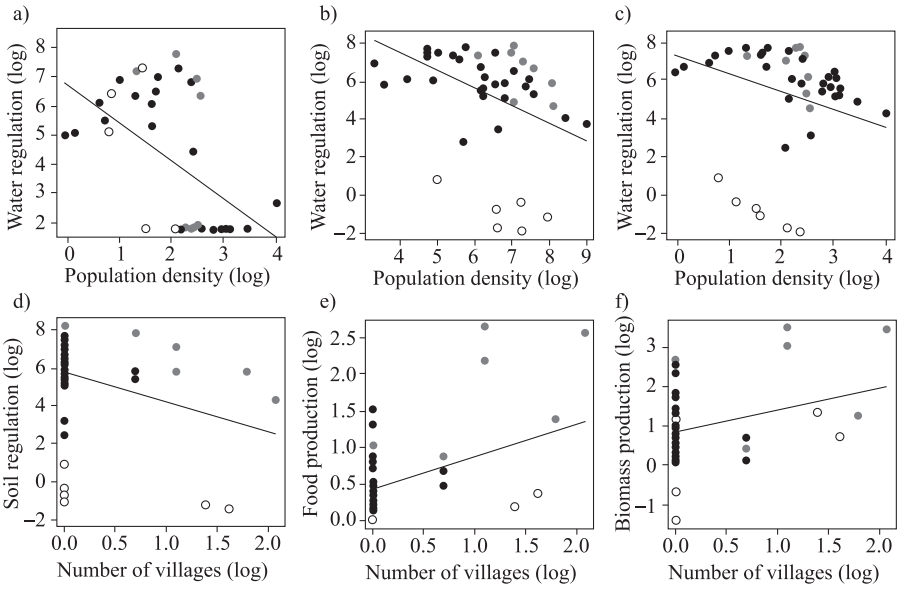


图 9-3　散点图①

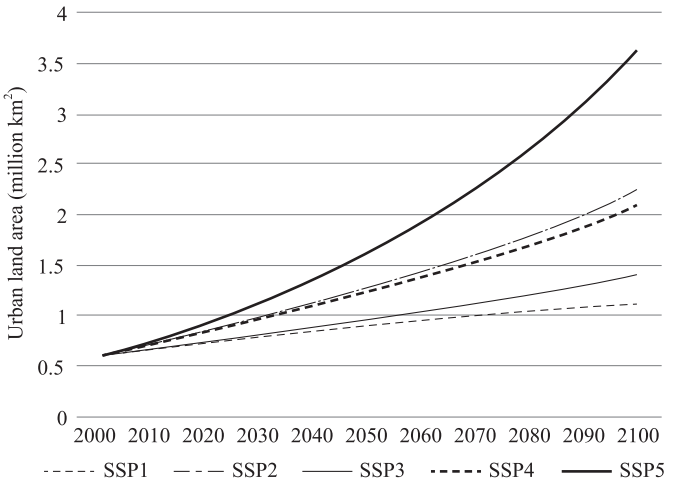


图 9-4　折线图②

3. 柱状图(Bar Chart)，主要是使用矩阵条对不同类别的数值进行比较。在图 9-5 中，作者采用柱状图展示了在一定期间内(1987—2019 年)水鸟多样性高值区自然和人工生境的多样性、破碎化指数变化趋势，以便读者在阅读过程中可以清晰地了解到二者在特定时间内是如何变化的。

① Daniel B.，Ricardo S.，BegoñaÁ.，et al. Depopulation impacts on ecosystem services in Mediterranean rural areas. Ecosystem Services，2021(52)：101369.

② Gao J.，O'Neill B. C.. Mapping global urban land for the 21st centurywith data-driven simulations and SharedSocioeconomic Pathways. Nature Communications，2020，11：2302.

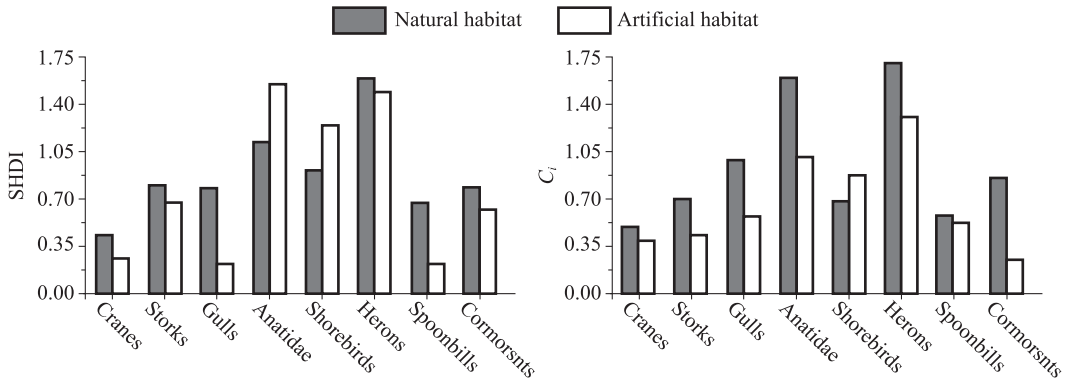


图 9-5　柱状图[①]

4. 堆叠柱状图(Compound Bar Chart),是柱状图的变形。图 9-6 便是以堆叠柱状图的形式,来比较不同类别的数值,用以说明不同地点的声源类型,同时反映出“总量”与“结构”间的关系,即总量是多少？由哪些部分构成的？进而还可以探究哪一部分比例最大,以及每一部分的变动情况等。

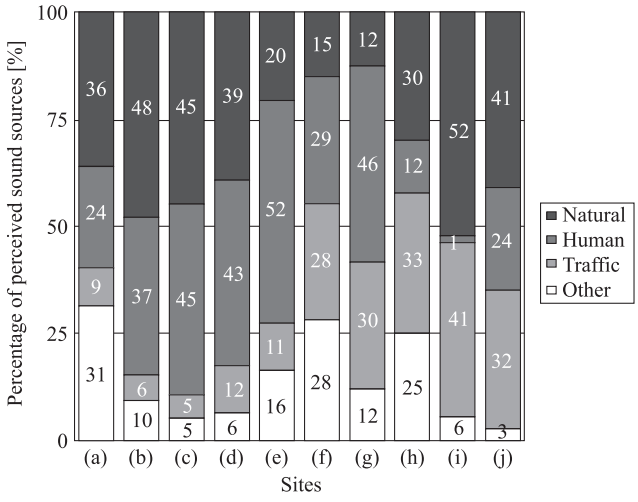


图 9-6　堆叠柱状图[②]

5. 饼图(Pie Chart),其最显著的功能在于表现“占比”。如图 9-7 所示,作者通过采用饼图,用以说明各组分差异在营养因子和理化因子之间的分配关系。相应的,读者可以根据每一部分的占比情况,判断其影响程度的强弱关系。

① Wang C, Wang G, Dai L J, et al. Study on the effect of habitat function change on waterbird diversity and guilds in Yancheng coastal wetlands based on structure-function coupling. Ecological Indicators, 2021,122:107223.

② Jo H. I., Jeon J. Y. Urban soundscape categorization based on individual recognition, perception, and assessment of sound environments. Landscape and Urban Planning, 2021,216:104241.

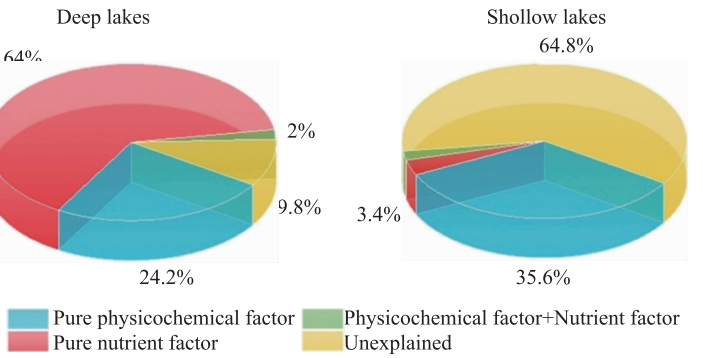


图 9-7　饼状图[①]

6. 面积图(Area Graph),是一种随时间变化而改变范围的图表,主要强调数量与时间的关系。如图 9-8 所示,通过堆叠面积图说明 2015—2050 年各类能源供应总量的变化,不仅表示了数值大小的变化情况,还反映出每一类能源在不同时间内供应量发展变化情况,以便于读者把握整体变化趋势。

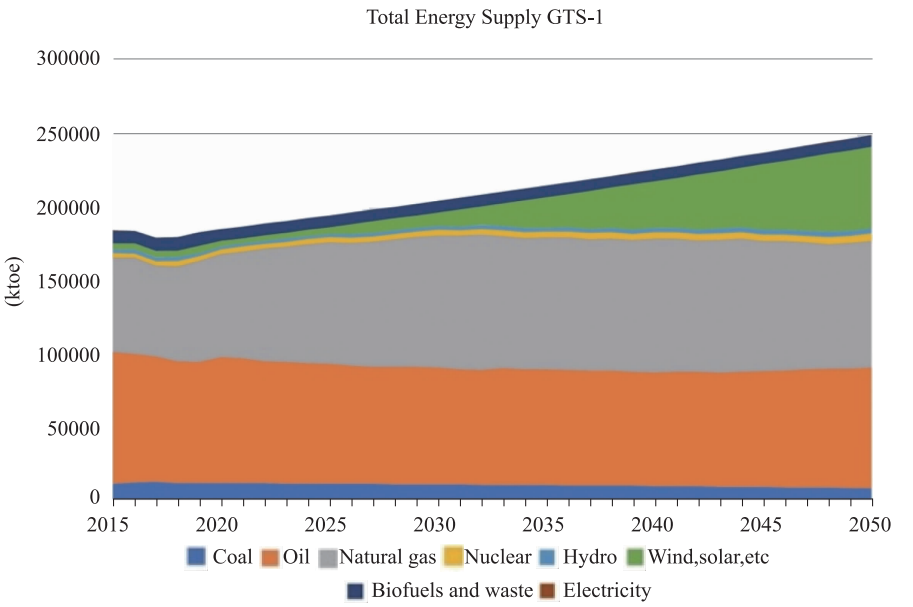


图 9-8　堆叠面积图示意图[②]

7. 雷达图(Radar Chart),是一种可以在同一坐标系内展示出对多个变量相互关系进行比较的图形。在图 9-9 中,作者为了对生态系统服务功能的动态变化进行具体评估,采用雷达图比较了 2000—2015 年 6 个地理区域中 6 个标准化生态系统服务功能(水产量、生态系统碳储

① Song X Y, Zhang C H, Su X Y, et al. Characteristics of humic substance in lake sediments: the case of lakes in northeastern China. Journal of Hydrology,603. https://doi.org/10.1016/j.jhydrol.2021.127079.

② Peña L. D. L., Guo R, Cao X J, et al. Accelerating the energy transition to achieve carbon neutrality. Resources, Conservation & Recycling, 2022(177):105957.

量、土壤保持、沙尘暴防治、生境适宜性好的区域、粮食年产量)的变化情况。方便读者对各要素的变化情况作出全局性、整体性以及不同地理区域变化特征之间差异性的综合评价。

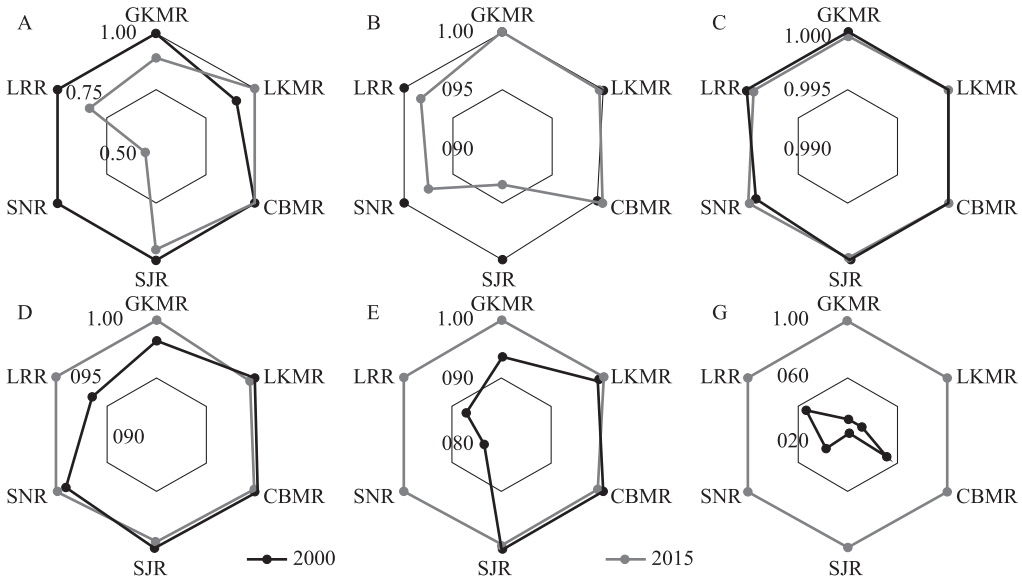


图 9-9　雷达图示意图[①]

8. 箱线图(Box Plot),主要用于反映一组或多组数据的分布情况。例如,在图 9-10 中,具体展现了恢复农业生态系统中生物多样性水平以及支持和调节生态系统的平均效应大小(响应比)的评估结果。读者通过分析该图,结合图表说明,能够快速准确了解到一些关键统计值。对于对应数值的平均效应量差异情况,如是否存在异常值、数据间的离散程度等,也能够做到一目了然。

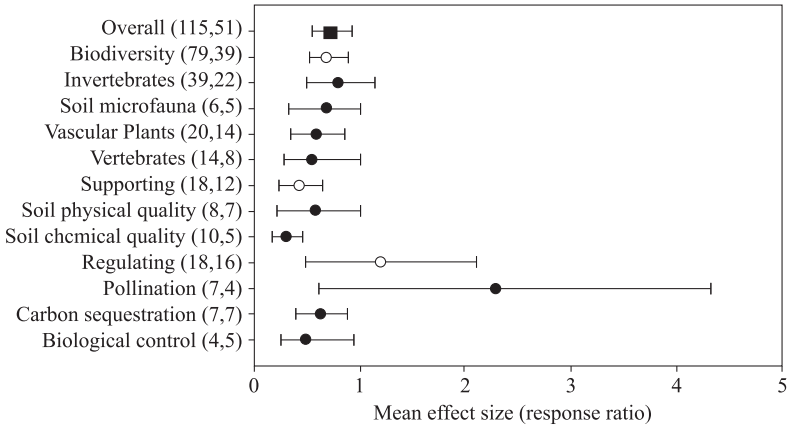


图 9-10　箱线图[②]

① Mao D H, He X Y, Wang Z M, et al. Diverse policies leading to contrasting impacts on land cover andecosystem services in Northeast China. Journal of Cleaner Production, 2019(240):117961.

② María P. B., José María r. b., Paula M. et al. Quantifying the impacts of ecological restoration on biodiversity and ecosystem services in agroecosystems: A global meta-analysis. Agriculture, Ecosystems and Environment, 2015(202): 223-231.

9. 南丁格尔玫瑰图(Nightingale Rose Charts),用于对比不同分类的大小,可以反映组成关系并进行比较。在图 9-11 中,作者将 40 个城市划分为 4 个生态系统服务束,每个玫瑰图分别代表着生态系统服务高供给区、生态系统服务调节-供给区、生态系统服务调节区以及低生态系统服务供给区。图中每个花瓣的长度与每个束内其它生态系统服务的相对丰度成正比。读者阅读后,不难看出每个生态系统服务束所体现生态系统服务的多样性,并对不同生态系统服务之间可以进行整体性的大致比较,其区别一目了然。

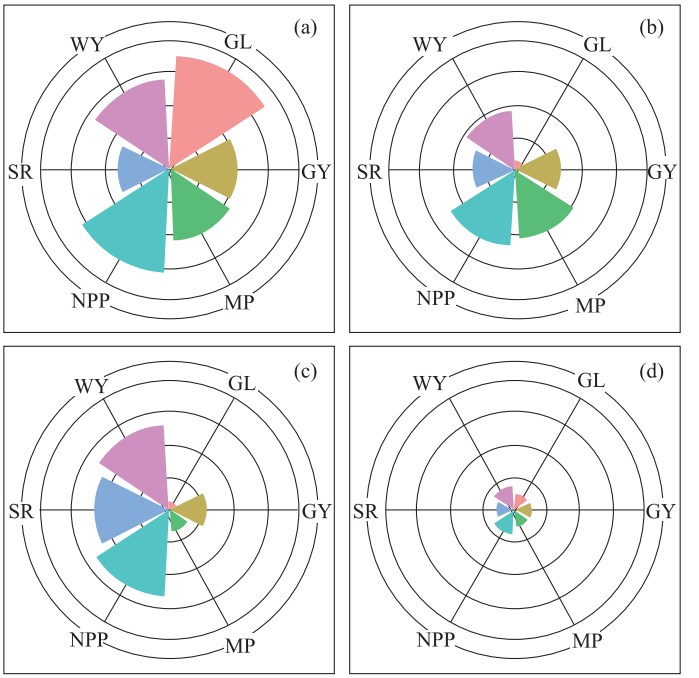


图 9-11　南丁格尔玫瑰图示意图[①]

10. 热图(Heatmap),利用不同的色块,把对象分成不同的等级区间,以分区展示不同的数据。如图 9-12 所示,通过热力图,量化出生态风险系数差异,色块颜色由浅至深的变化,直观地揭示了分布特征。

(二)影像图

主要包括研究区概况图、特定实验中用于展示实验过程或结果的相关图件。如图 9-13 所示,作者通过三个套图,其中两个是行政边界图,一个是具体研究区的遥感影像图,着重介绍了深圳市在中国以及广东省两个层面上的地理位置、土地利用覆被情况,以帮助读者尤其是国际读者形象客观地了解研究区的基本地理位置和地貌特征等。

① Liu Y X, Lü Y H, Fu B J, et al. Quantifying the spatio-temporal drivers of planned vegetation restoration on ecosystem services at a regional scale. Science of the Total Environment, 2019(650): 1029-1040.

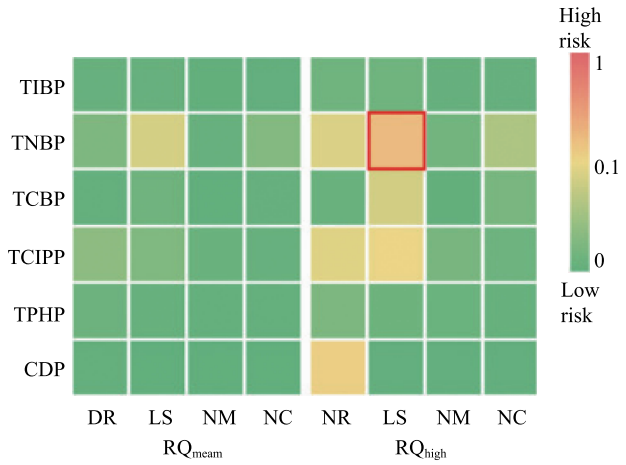


图 9-12　热力图[①]

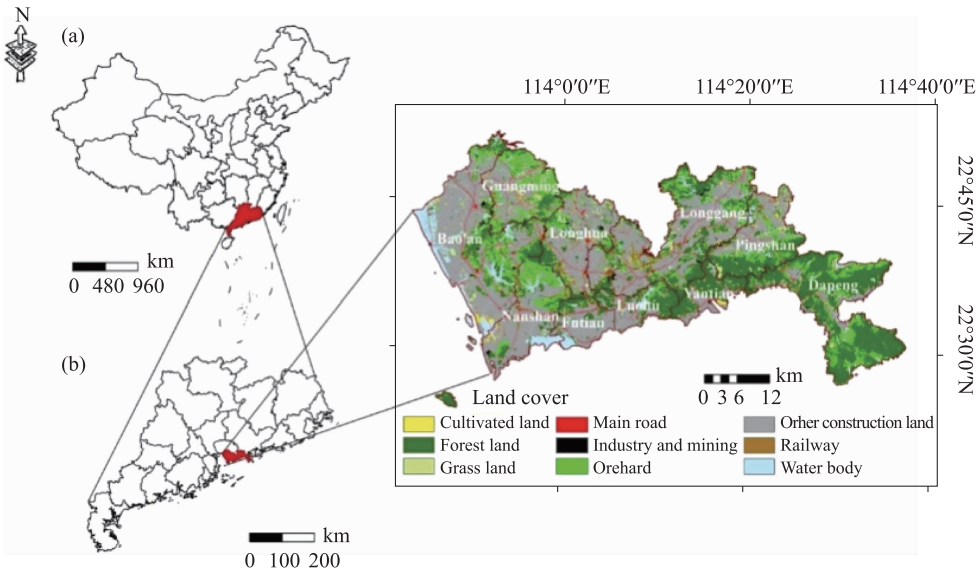


图 9-13　研究区概况图[②]

（三）示意图

1. 研究过程示意图（Research Flow Framework），是一种应用较广泛的示意图。主要用于阐释行文的思路、研究过程等内容。在图 9-14 中，作者通过该种方式，介绍了黄土高原中社会生态系统演进的框架，阐释了主要驱动因素和溢出效应，以帮助读者快速理解文章的研究框架和脉络，同时也可以帮助读者在短时间内了解文章的行文逻辑结构，获取关键信息。

① Zhang Z H, Xu Y, Wang Y, et al. Occurrence and distribution of organophosphate flame retardants in the typical soil profiles of the Tibetan Plateau, China. Science of the Total Environment, (2022)150519.

② Luo Y H, Wu J S, Wang X Y, et al. Can policy maintain habitat connectivity under landscape fragmentation? A case study of Shenzhen, China. Science of the Total Environment, 2020,715:136829.

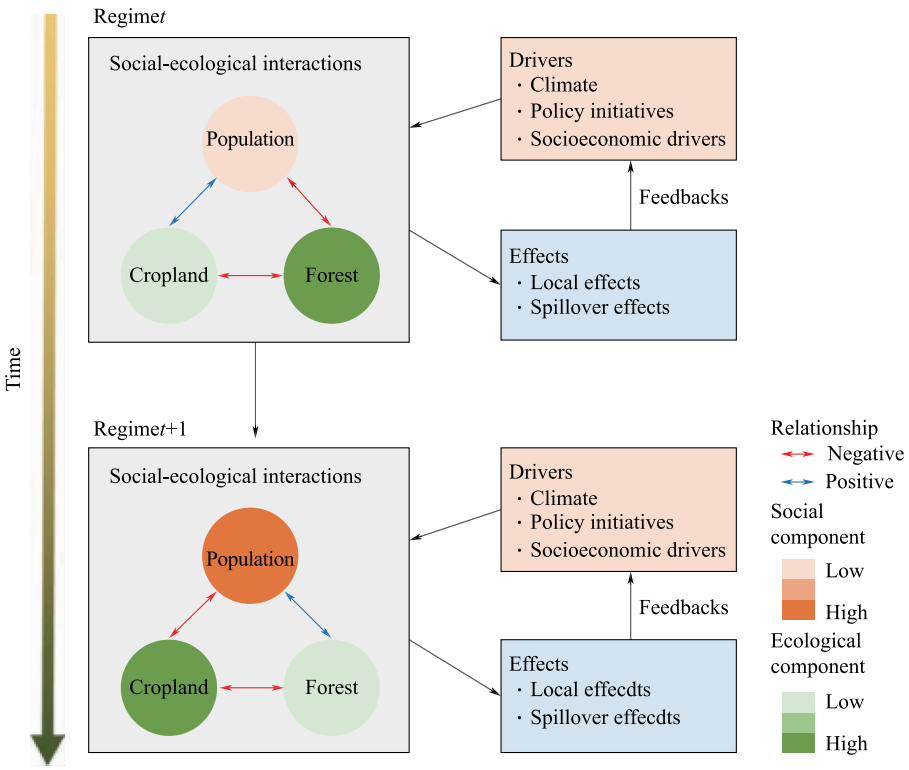


图 9-14　研究过程示意图[①]

2. 工作原理示意图(Illustration of Working Dynamic and Mechanism)，主要用于描述工作原理、工艺过程的示意图。如图 9-15 所示，作者形象地展示了文中提到的测试系统。读者据此可以掌握这一测试系统由哪几个部分组成、每一个部分的具体作用是什么、如何运作等关键信息。

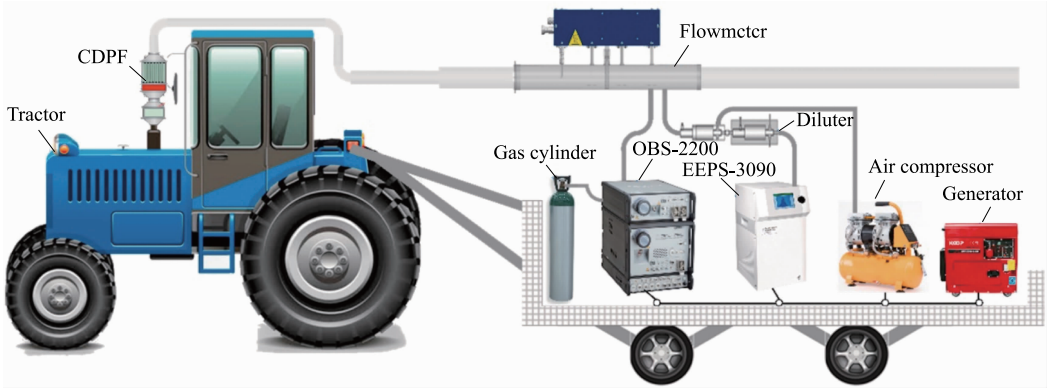


图 9-15　工作原理示意图[②]

① Wu X T, Wei Y P, Fu B J, et al. Evolution and effects of the social-ecological system over a millennium in China's Loess Plateau. Science Advances, 2020; 6: eabc0276

② Zhang Y H, Lou D M, Hu Z Y, et al. Emission characteristic of non-road mobile machinery using a catalyseddie-selparticle filter with different catalyst loadings under actual operating conditions. Journal of Cleaner Production, 327(2021) 129482.

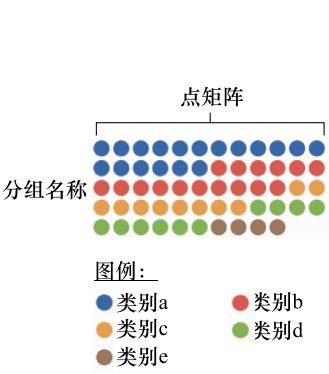
通过上述案例，我们可以看出，无论是哪种类型的图，都包含图序、图题、图注等基本要素。初学者在具体绘制时，要注意做到图的基本要素完备，即：

(1)每一个图都要按照在论文中出现的先后顺序连续编排。即使全文只有一幅图，也需要给予编序，如 Figure 1 或 Fig. 1。具体的图序编排方法，以目标期刊的要求为准。

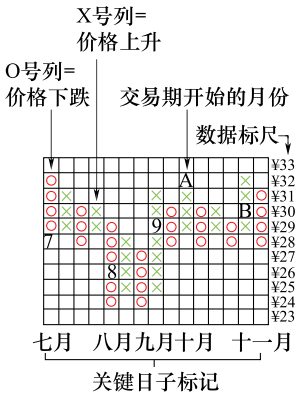
(2)图题要做到力求简洁，能够准确概括出图中所描述的主要内容和关键信息，达到阅读图件时不需要通过正文文字的补充说明，也能够独立存在的基本标准，即具有说明性和专指性。图件不能出于过于追求形式上的简洁，而导致内容上的欠缺，出现泛指等笼统性语句。

(三)其它插图类型

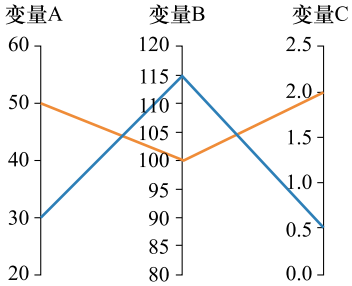
以上基本插图类型在科学论文中使用比较频繁。除此之外，还可能会见到以下一些插图。此处增补出来，读者一方面可以了解，拓展眼界；另一方面也可以作为储备，以备不时之需。



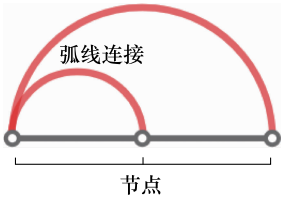
点阵图 (Dot Matrix Chart)



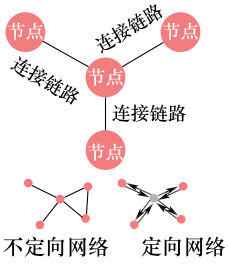
点数图 (Point & Figure Charts)



平行坐标图 (Parallel Coordinates Plots)

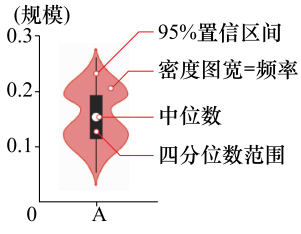


弧形连接图 (Arc Diagram)

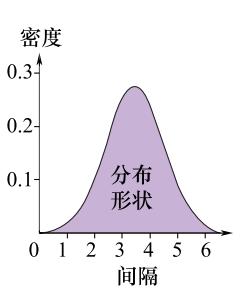


节点连接图 (Node Link Graph)

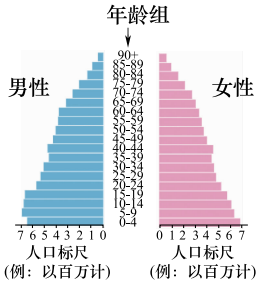
象形图 (Pictogram Chart)



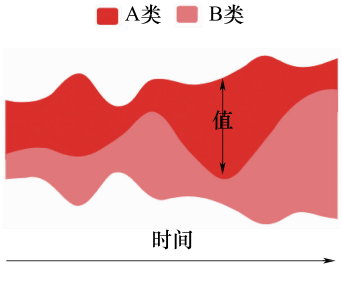
小提琴图 (Violin Plot)



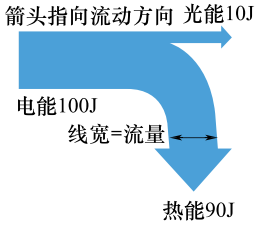
密度图 (Density Plot)



人口金字塔图 (Population Pyramid)

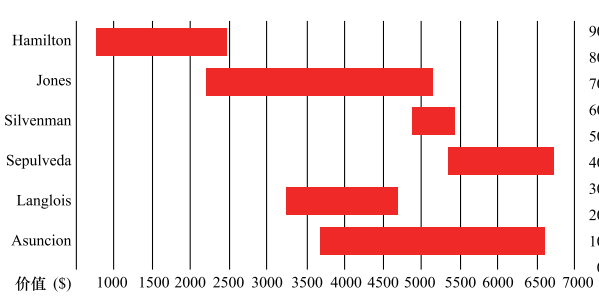


波形图 (Quantized Waveform)

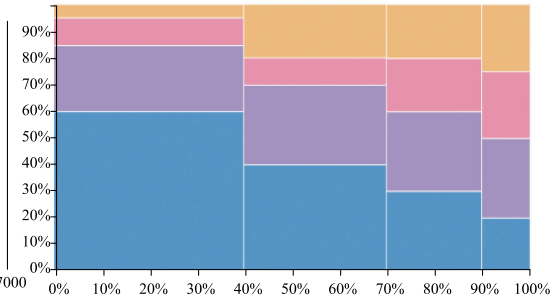


桑基图 (Sankey Diagram)

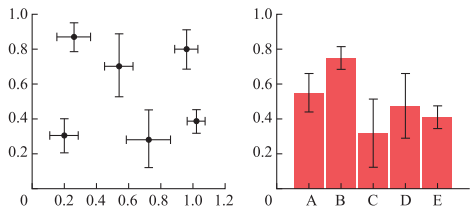
100%



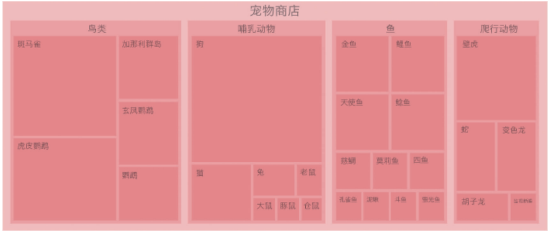
悬浮柱状图 (Floating Bar Chart)



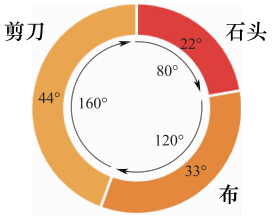
马赛克图 (Marimekko Chart)



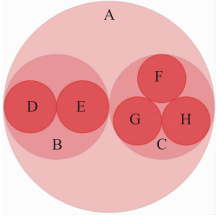
误差条形图 (Error Bar)



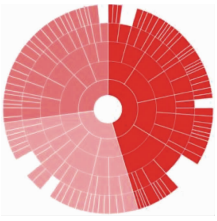
矩形树图 (Treemap)



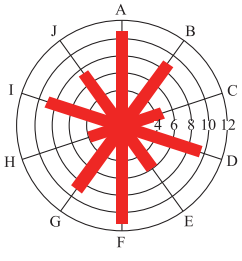
圆环图 (Donut Chart)



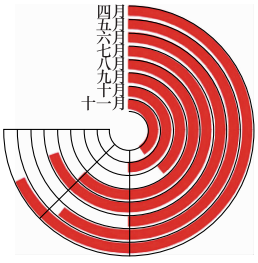
圆形填充图 (Circle Packing)



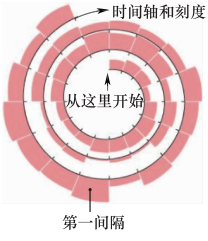
径向树形图 (Radial Tree Diagram)



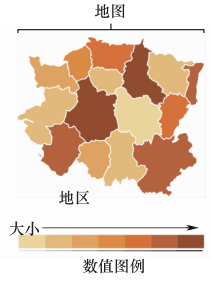
径向列图
(Radial Column Graph)



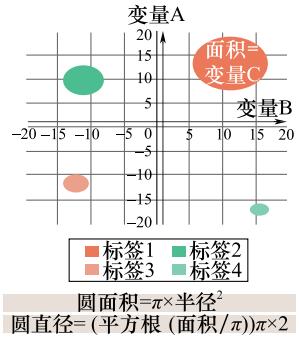
径向条形图
(Radial Bar Graph)



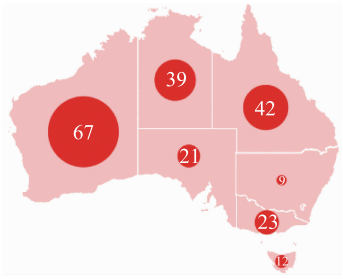
阿基米德螺旋线
(Archimedean Spiral)



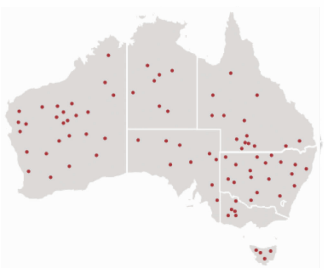
分布图
(Distribution Map)



气泡图 (Bubble Chart)



气泡地形图 (Bubble Topographic Map)

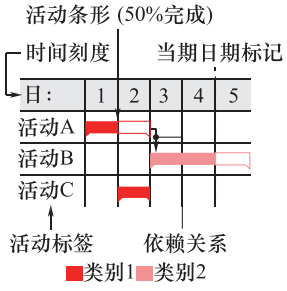


点图 (Point Map)

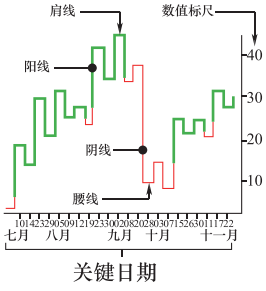
连接映射图 (Connection Map)

流型图 (Flow Map)

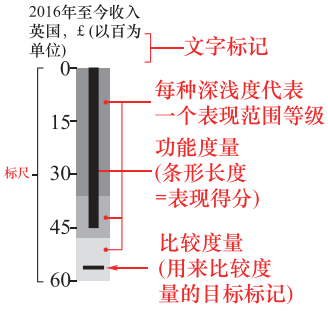
弦图 (Chord Diagram)



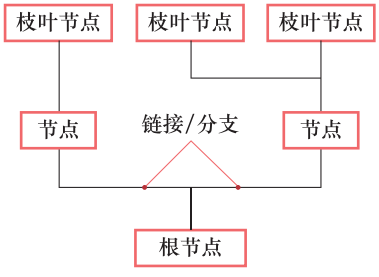
甘特图 (Gantt Chart)



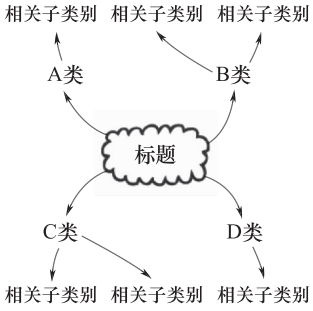
卡吉图 (Kagi Chart)



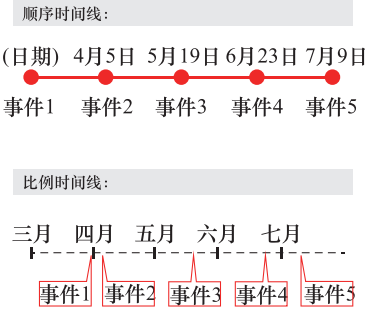
靶心图 (Bullet Graph)



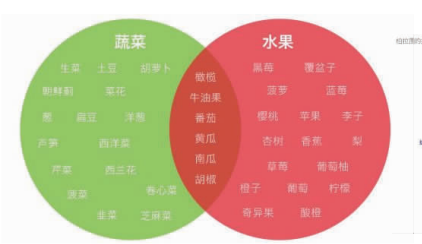
树形图 (Tree Diagram)



灵感触发图 (Brainstorming Diagram)

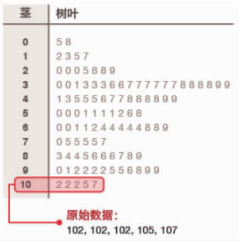


时间线图 (Timeline)



韦恩图 (Venn Diagram)

词云图 (Word Cloud)



茎叶图 (Stem & Leaf Plots)

由此可以看到，论文撰写过程中，可以采用的图表类型种类繁多。不同的图表，所传达的数据信息效果各有侧重。列举的案例展示了一些基础图表类型。在符合基本规范的前提下，具体采用哪种形式的图表，也包含了个人的审美在内。我们想要强调的是，初学者通过对比分析以上各种类型的图表，领会科学论文写作过程中图表绘制的一些技巧，形成基本的思维惯性。当然，绘制图表应该以文章主旨内容服务为宗旨，结合目标期刊要求选择合适的图表，而不是为了绘制图表而制作图表。总体上，只有在平时文献阅读过程中，才会更好的继续深入了解和掌握不同类型图表的正确使用方法。

第二节　图表设计

设计图表是在了解目标期刊相关要求的基础上，精心规划哪些数据信息需要向读者呈现、通过何种形式表达和传递关键信息，确保信息传递效率，使读者能够准确获取研究的重点内容和主要成果。

一、设计基本要求

（一）突出重点

设计要基于成果的表达，做到简明扼要，尽量删除不必要的文字，省去次要部分，在内容和视觉效果上突出重点，强调传递给读者的是关键信息。图表不是越多越好。要根据必要性，进行精选。做到突出那些有规律性、能够说明主题的内容或数据。通常可以用一两句话说清楚的内容，不必列表。凡是已经在正文中表述过的内容或已用图说明的内容，同样不需要列表，以避免重复。

（二）表述简洁

图表设计应该着重反映事物的真实形态、运动变化规律、有序性和数量关系等，不能主观臆造，也不能随意夸张。选择要包含在表中的信息时，要考虑数据的完整性和重要性，除列出重要的现象、参数、算式和结论外，应删除分析或运算过程中的中间步骤和环节。

（三）制作规范

图表设计要做到基本构成要素完整，不遗失。要力求做到传递的数据或论点清晰准确，同时还应避免堆积过多的细节，造成阅读和理解上的困难。在涉及到各种符号、量名称及其单位、名词术语等时，必须符合国际标准和有关行业标准或遵照目标期刊 Author Guideline 要求，做到与 full text 表述一致。

（四）独立完整

图表表达的内容要服务于论文的主题，与文字表述有机地构成一体，共同阐释论文核心内容。在此基础上，要保证图表独立性，使得读者不读正文也能够获得有效信息，理解图表所要表达的内容。

二、不同期刊要求对比

不同期刊对图表的要求，尽管存在很多相似之处，如提供高分辨率图像、图形在正文中引用说明、图表说明要简洁全面、对使用的符号、缩写、单位等解释说明、表中涉及到的细节性内容需要脚注说明、提交的表格是可编辑的文本而不是图像等等；但是，也有很多不同之处。表9-1展示了4个不同期刊对图表要求的一些不同之处，供初学者参考。

表 9-1　不同期刊对图表的要求

期刊名称	学科/分区/IF[1]	图表要求
Nature Communications①	综合性 1区 TOP 16.6	• Provide images in RGB color and at 300 dpi or higher resolution. • Use the same typeface (Arial or Helvetica) for all figures. Use symbol font for Greek letters. • Use distinct colors with comparable visibility and avoid the use of red and green for contrast. Recoloring primary data, such as fluorescence images, to color-safe combinations such as green and magenta or other accessible color palettes is strongly encouraged. Use of the rainbow color scale should be avoided. • Figures are best prepared at the size you would expect them to appear in print. At this size, the optimum font size is between 5pt and 8pt. • We prefer vector files with editable layers. Acceptable formats are: .ai, .eps, .pdf, .ps and .svg for fully editable vector-based art; layered .psd and .tif for editable layered art; .psd, .tif, .png and .jpg for bitmap images; .ppt if fully editable and without styling effects; ChemDraw (.cdx) for chemical structures. • Please use the Nature Research Chemical Structures Guide and ChemDraw template for formatting of chemical structures. • Each table should be accompanied by a short title sentence describing what the table shows.
Evolution②	ES&E[2] 2区 3.3	• Although authors are encouraged to send the highest-quality figures possible, for peer-review purposes, a wide variety of formats, sizes, and resolutions are accepted. But the journal proves the basic figure requirements for figures submitted with manuscripts for initial peer review, as well as the more detailed post-acceptance figure requirements. • All figures included in submission as single, original, unconverted files. • Changes to images can create misleading results when research data are collected as images. It may, however, be legitimate can even necessary to edit images. We ask authors to declare where manipulations have been made. • Tables should be self-contained and complement, not duplicate, information contained in the text.

① https://www.nature.com/ncomms/submit/guide-to-authors

② https://onlinelibrary.wiley.com/page/journal/15585646/homepage/forauthors.html

续表

期刊名称	学科/分区/IF[1]	图表要求
Journal for Nature Conservation①	ES&E 3区 2.0	• Make sure you use uniform lettering and sizing of your original artwork. • Embed the used fonts if the application provides that option. • Aim to use the following fonts in your illustrations: Arial, Courier, Times New Roman, Symbol, or use fonts that look similar. • Number the illustrations according to their sequence in the text. • Use a logical naming convention for your artwork files. • Size the illustrations close to the desired dimensions of the published version. • Submit each illustration as a separate file. • Tables can be placed either next to the relevant text in the article, or on separate page(s) at the end. • Number tables consecutively in accordance with their appearance in the text and place any table notes below the table body. • Be sparing in the use of tables and ensure that the data presented in them do not duplicate results described elsewhere in the article. • Please avoid using vertical rules and shading in table cells.
Water Policy②	ES&E 4区 1.6	• All figures and tables should be embedded in the text where possible, unless otherwise requested by the publisher. (• The journal is printed in black and white, with colour graphics in the online version. • Figures should appear in numerical order, be described in the body of the text and be positioned close to where they are first cited. The caption should be given in the text, and not on the figure itself. • Make sure all figures and tables will fit inside the text area. • Because figures may be resized in the course ofproduction, please use scale bars and not magnification factors.

注:(1)IF 值更新为 2023 年。(2)Environmental Science & Ecology, ES&E,环境科学与生态学

三、Nature、Science 和 PNAS 的制图要求及案例示范

(一)*Nature*③

1. 制图要求

(1)对于表格的要求:

—*Tables should each be presented on a separate page, portrait (not landscape) orientation, and upright on the page, not sideways.*(表格呈现形式)

—*Tables have a short, one-line title in bold text. Tables should be as small as possible. Bear in mind the size of a Nature page as a limiting factor when compiling a table.*(表格标题与大小)

① https://www.elsevier.com/journals/journal-for-nature-conservation/1617-1381/guide-for-authors

② https://iwaponline.com/wp/pages/Instructions_for_authors

③ https://www.nature.com/nature/for-authors/formatting-guide

—*Symbols and abbreviations are defined immediately below the table, followed by essential descriptive material as briefly as possible, all in double-spaced text.*（表格中的符号和缩写呈现位置与格式要求）

—*Standard table formats are available for submissions of cryo-EM, NMR and X-ray crystallography data. Authors providing these data should use these standard tables for inclusion as Extended Data tables.*（表格数据格式）

(2)对于图件的要求包括 Figure legends 和 Figures 两部分,具体是:

—*For initial submissions, we encourage authors to incorporate the manuscript text and figures together in a single Word doc or PDF file, and for each figure legend to be presented together with its figure. However, if a paper is accepted, we require figure legends to be listed one after the other, as part of the text document, separate from the figure files.*（分情况图例呈现形式）

—*Each figure legend should begin with a brief title for the whole figure and continue with a short description of each panel and the symbols used. For contributions with methods sections, legends should not contain any details of methods, or exceed 100 words (fewer than 500 words in total for the whole paper). In contributions without methods sections, legends should be fewer than 300 words (800 words or fewer in total for the whole paper).*（图表说明内容与字数要求）

—*All error bars must be defined in the figure legend, as discussed above.*（特别说明所有的误差必须在图例中交代清楚）

—*Nature requires figures in electronic format. Please ensure that all digital images comply with the Nature journals' policy on image integrity.*（图的提交格式）

—*Figures should be as small and simple as is compatible with clarity. The goal is for figures to be comprehensible to readers in other or related disciplines, and to assist their understanding of the paper. Unnecessary figures and parts (panels) of figures should be avoided: data presented in small tables or histograms, for instance, can generally be stated briefly in the text instead. Avoid unnecessary complexity, colouring and excessive detail.*（图尽量小并且简洁保证清晰度）

—*Figures should not contain more than one panel unless the parts are logically connected; each panel of a multipart figure should be sized so that the whole figure can be reduced by the same amount and reproduced on the printed page at the smallest size at which essential details are visible. For guidance, Nature's standard figure sizes are 89 mm (single column) and 183 mm (double column) and the full depth of the page is 247 mm.*（图的尺寸大小）

—*Amino-acid sequences should be printed in Courier (or other monospaced) font using the one-letter code in lines of 50 or 100 characters.*（打印要求）

除了上述一般性要求外,还包括其它一些细节性的要求,如:

—*Lettering in figures (labelling of axes and so on) should be in lower-case*

type, with the first letter capitalized and no full stop.(首字母大写没有句号)

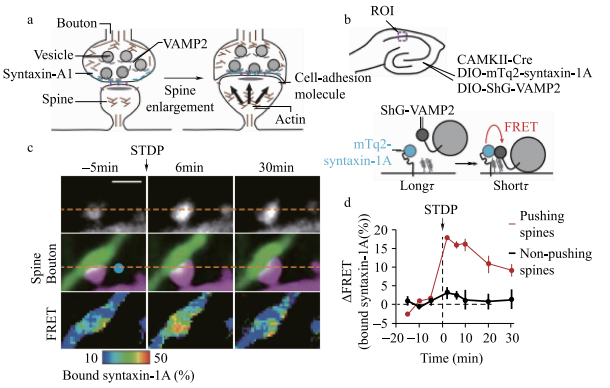
—*Units should have a single space between the number and the unit, and follow SI nomenclature or the nomenclature common to a particular field. Thousands should be separated by commas* (1,000). *Unusual units or abbreviations are defined in the legend.*(单位和数字之间有一个空格且不常见的单位或缩写应在图例中定义)

—*Scale bars should be used rather than magnification factors.*(应使用比例尺)

—*Layering type directly over shaded or textured areas and using reversed type* (*white lettering on a coloured background*) *should be avoided where possible.*(避免直接使用分层类型)

—*Where possible, text, including keys to symbols, should be provided in the legend rather than on the figure itself.*(包括符号在内的文本应在图例中提供)

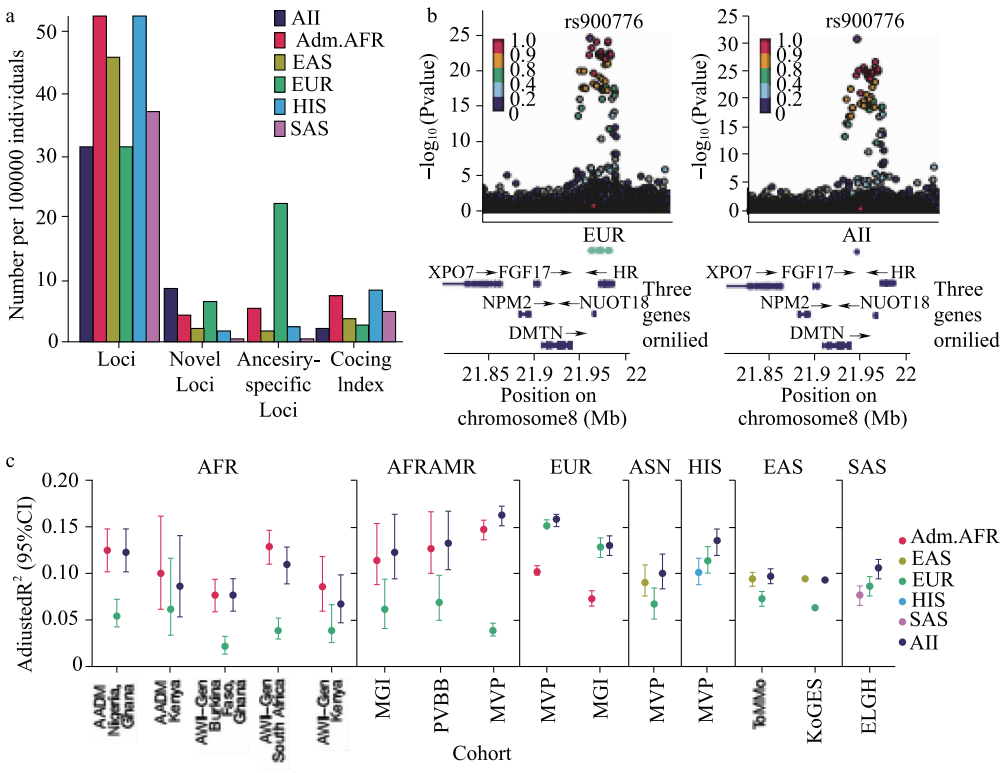
2. 案例赏析



Pressure sensation and transduction triggered by enlargement of presynaptic spines. a, An illustration of the mechanics in the synapse. Syntaxin-A1 and VAMP 2 proteins are part of the SNAREcomplexes. b, Schematic of the injection of the viruses used for imaging using Förster resonance energytransfer (*FRET*) *into the hippocampus and the FRET imaging location* (*top*). *The FRET constructs of theSNARE complexes and activation of FRET when syntaxin-A1-and VAMP 2-containing constructs are in closeproximity* (*short* τ) (*bottom*). *ROI, region of interest;* τ, *fluorescence lifetime. c, Fluorescence images ofa dendritic spine* (*top*), *overlay images of the spine and bouton* (*middle*) *and FRET images of the bouton* (*bottom*) *before and after spine enlargement. Scale bar,* 1μ*m. The horizontal dashed lines depict theoriginal position of the spine tip. Note the slight elongation of the spine. STDP, spike-timing dependentprotocol. d, The mean time courses for changes in FRET signals in the presynaptic terminal for pushing* (*red*) *compared with non-pushing* (*black*) *spine enlargements.*

图 9-16　例 1[①]

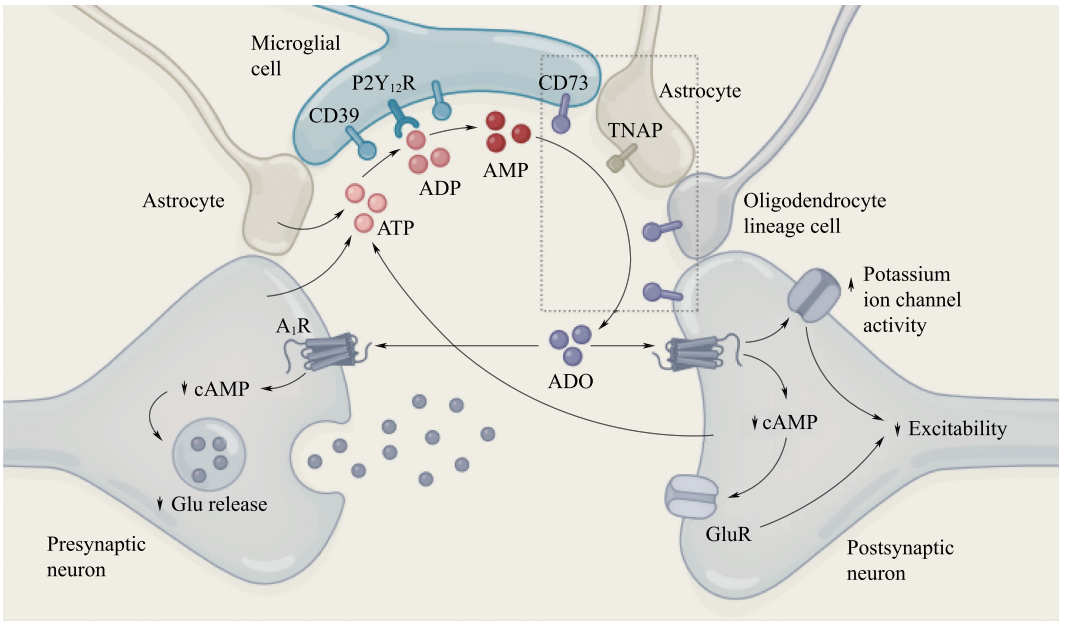
① Ucar, H. et al. Mechanical actions ofdendritic-spine enlargement on presynapticexocytosis. Nature, 600,686-689 (2021).



Multi-versus single-ancestry genome-wide association studies. a, After adjusting for sample size, we found slightly more genetic risk loci in people of Hispanic (HIS) and admixed African (Adm. AFR) ancestry than in those of East Asian (EAS), European (EUR) or South Asian (SAS) ancestry or for all ancestriescombined. b, The multi-ancestry genome-wide association study (GWAS) improved fine-mapping at 56%of loci, including for DMTN. c, The multi-ancestry risk score predicted LDL-C levels best, or near-best, in allancestries. Even though the African ancestry component was only 8% of the multi-ancestry GWAS, the scorewas equally predictive for individuals of African American (AFRAMR) or continental African ancestry asfor those of European ancestry. AADM, Africa America Diabetes Mellitus; AWI-Gen, Africa Wits—INDEPTH partnership for Genomic Studies; CI, confidence interval; ELGH, East London Genes and Health; KoGES, Korean Genome and Epidemiology Study; MGI, Michigan Genomics Initiative; MVP, Million VeteranProgram; PMBB, Penn Medicine BioBank; ToMMo, Tohoku Medical Megabank Community Cohort Study.

图 9-17　例 2[①]

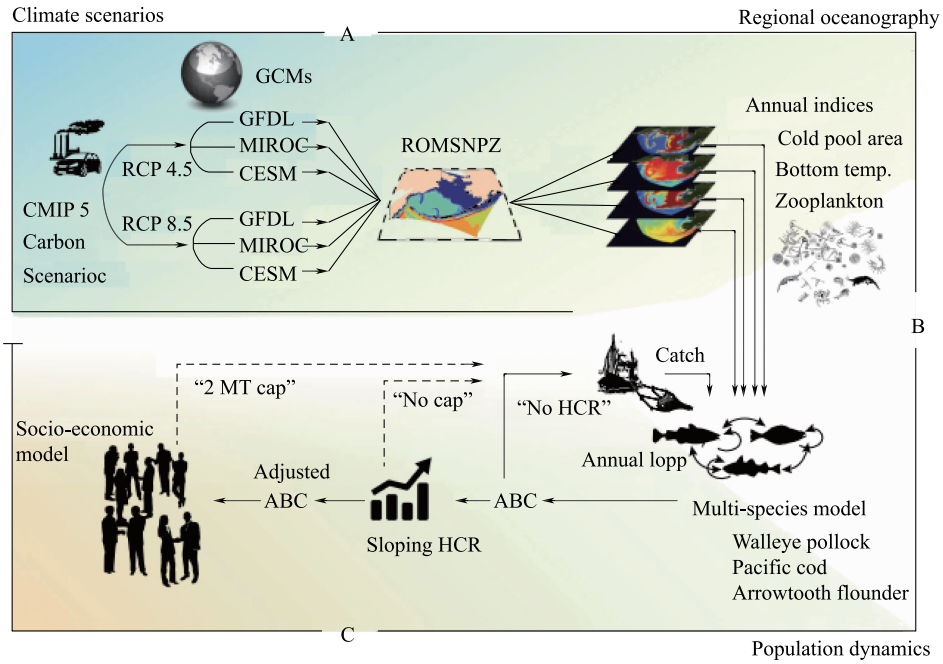
① Graham, S. E. et al. The power of geneticdiversity in genome-wide association studiesof lipids. Nature,600,675-679(2021).



Mechanism for microglial inhibition. The mechanism by which microglia exert their effectinvolves the molecule ATP, which is released by active neurons and their associated astrocytes, and isconverted into ADP by the microglial enzyme CD39. ADP acts on P2Y12 receptor (P2Y12R) proteins to attractmicroglial processes to synaptic connections between neurons that are repeatedly active (not shown). CD39 also converts ADP into AMP, which is converted into ADO —this step might be catalysed by the enzymeCD73 on microglia, oligodendrocyte lineage cells or neurons, and/or by the enzyme non-tissue-specificalkaline phosphatase (TNAP) on astrocytes (uncertainty indicated by dashed box). ADO suppressesneuronal activity by acting on its A1 receptors (A1Rs). These lower the concentration of cyclic AMP (cAMP) molecules, which in turn decreases Glu release in presynaptic neurons and decreases the response ofGlu receptors (GluRs) in postsynaptic neurons. In addition, A1Rs activate potassium ion channels6, so reducing neuronal excitability.

图 9-18　例 3[①]

① Pfeiffer T., Attwell D. Brain's immune cells put the breaks on neurons. Nature, 2020,586(7829):366-367.



Model coupling framework. a Regional downscaling where three global climate models driven by the IPCC AR5 CMIP5 emission scenariosdetermine boundary conditions of the coupled ROMSNPZ high resolution oceanographic model for the Bering Sea, AK. b Biological downscaling of annualindices from the ROMSNPZ were used to drive thermal parameters in the CEATTLE model (i.e., weight-at-age and predation) as well as climate-enhancedspawner-recruitment relationships. c Annual harvest recommendations (ABC) from the assessment model which were translated into annual catch usingthe ATTACH social-economic model of the effect of EBFM policies on harvest.

图 9-19　例 4[①]

(二)*Science*[②]

1. 制图要求

(1)对于表格的要求：

Tables should be included after the references and should supplement, not duplicate, the text. They should be called out within the text and numbered in the order of their citation in the text. The first sentence of the table legend should be a brief descriptive title. Every vertical column should have a heading, consisting of a title with the unit of measure in parentheses. Units should not change within a column. Footnotes should contain information relevant to specific entries or parts of the table.

① Holsman, K. K., Haynie, A. C., Hollowed, A. B. et al. Ecosystem-based fisheries management forestalls climate-driven collapse. Nature Communication, 2020,11,4579.

② https://www.science.org/content/page/instructions-preparing-initial-manuscript

(2)对于图件的要求：

—*It is best to create your figures as vector-based files such as those produced by Adobe Illustrator. Vector-based files will give us maximum flexibility for sizing your figures properly without losing resolution, as they can be altered in size while maintaining high print-quality resolution. We cannot accept PowerPoint files or files that are not readable by Adobe Photoshop, Macromedia Freehand, or Adobe Illustrator. To keep file sizes reasonable, please save art at a resolution of 150 to 300 dots per inch (dpi) for initial submission. A higher resolution applies for figures submitted at the revision stage-see instructions for preparing a revised manuscript. Digital color art should be submitted as CMYK (Cyan, Magenta, Yellow, Black) rather than RGB (Red, Green, Blue).*(图形文件格式、分辨率、颜色要求)

—*The width of figures, when printed, will usually be 5.5 cm (2.25 inches or 1 column) or 12.0 cm (4.75 inches or 2 columns). Bar graphs, simple line graphs, and gels may be reduced to a smaller width. Symbols and lettering should be large enough to be legible after reduction [a reduced size of about 7 points (2 mm) high, and not smaller than 5 points]. Avoid wide variation in type size within a single figure. In laying out information in a figure, the objective is to maximize the space given to presentation of the data. Avoid wasted white space and clutter.*(图形宽度)

—*The figure's title should be at the beginning of the figure legend, not in the figure itself.*(图形标题)

—*Include the figure's identifying number (e.g., "Fig. 1") on the same manuscript page that includes the figure.*(图形编号)

—*Keys to symbols, if needed, should be kept as simple as possible and be positioned so they do not needlessly enlarge the figure. Details can be put into the captions.*(关键符号)

—*Use solid symbols for plotting data if possible (unless data overlap or there are multiple symbols). Size symbols so that they will be distinguishable when the figure is reduced (6 pt minimum). Line widths should be legible upon reduction (minimum of 0.5 pt at the final reduced size).*(符号尺寸与行宽)

—*Panels should be set close to each other, and common axis labels should not be repeated.*(排版)

—*Scales or axes should not extend beyond the range of the data plotted.*(比例尺和坐标轴)

—*Use scale bars in place of, or in addition to, magnifications. Do not use minor tick marks in scales or grid lines. Avoid using y-axis labels on the right that repeat those on the left.*(使用比例尺)

—*Color*(颜色)

• *Avoid using red and green together. Color blind individuals will not be a-*

ble read the figure.

• Please do not use colors that are close in hue to identify different parts of a figure.

• Avoid using grayscale.

• Use white type and scale bars over darker areas of images.

• Use white type and scale bars over darker areas of images.

—Fonts(字体)

• Use a sans-serif font whenever possible (we prefer Helvetica).

• Simple solid or open symbols reduce well.

• Label graphs on the ordinate and abscissa with the parameter or variable being measured, the units of measure in parentheses, and the scale. Scales with large or small numbers should be presented as powers of 10.

• Avoid the use of light lines and screen shading. Instead, use black-and-white, hatched, and cross-hatched designs for emphasis.

• Capitalize the first letter in a label only, not every word (and proper nouns, of course).

• Units should be included in parentheses. Use SI notation. If there is room, write out variables—e. g., Pressure (MPa), Temperature (K).

• Variables are always set in italics or as plain Greek letters (e. g., P, T, m). The rest of the text in the figure should be plain or bold text.

• Type on top of color in a color figure should be in bold face. Avoid using color type.

• When figures are assembled from multiple gels or micrographs, a line or space should indicate the border between two original images.

• Use leading zeros on all decimals-e. g., 0. 3, 0. 55*-and only report significant digits.*

• Use capital letters for part labels in multipart figures-A, B, C, etc. These should be 9 *pt and bold in the final figure. When possible, place part labels at the upper left-hand corner of each figure part; if a part is an image, set labels inside the perimeter so as not to waste space.*

• Avoid subpart labels within a figure part; instead, maintain the established sequence of part labels [e. g., use A, B, C, D, E instead of A, B, C(a), C (b), C ©]. If use of subpart labels is unavoidable, use lowercase letters (a, b, c). Use numbers (1, 2, 3) *only to represent a time sequence of images.*

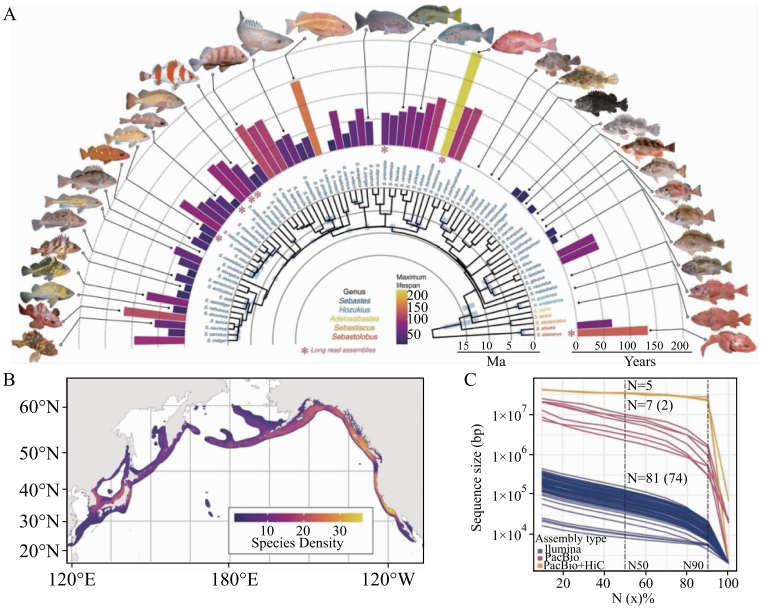
• When reproducing images that include labels with illegible computer-generated type (e. g., units for scale bars), omit such labels and present the information in the legend instead.

• Sequences may be reduced considerably, so the typeface in the original should be clear. There should be about 130 *characters and spaces per line for a se-*

quence occupying the full width of the printed page and about 84 characters and spaces per line for a sequence occupying two columns.

—Science does not allow certain electronic enhancements or manipulations of micrographs, gels, or other digital images. Figures assembled from multiple photographs or images, or non-concurrent portions of the same image, must indicate the separate parts with lines between them. Linear adjustment of contrast, brightness, or color must be applied to an entire image or plate equally. Nonlinear adjustments must be specified in the figure legend. Selective enhancement or alteration of one part of an image is not acceptable. In addition, Science may ask authors of papers returned for revision to provide additional documentation of their primary data.

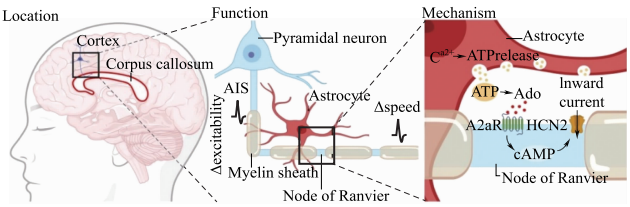
2. 案例赏析



Genome assemblies and relationships among rockfish species. (A) Ultrametric tree of therockfish species sequenced in this study and their associated maximum life spans along with representativeimages (node timing confidence intervals in light blue) created using IQ-TREE, ASTRAL (Accurate SpeciesTree Algorithm), and BPPR. Asterisks indicate individuals for which long-read sequencing-based genomeswere assembled. (B) The density of rockfish species (heatmap colors) throughout the Pacific Ocean. (C) Genome assembly statistics for 81 species, blue and pink represent N(x) contig lengths, while orangeindicates N(x) scaffold lengths.

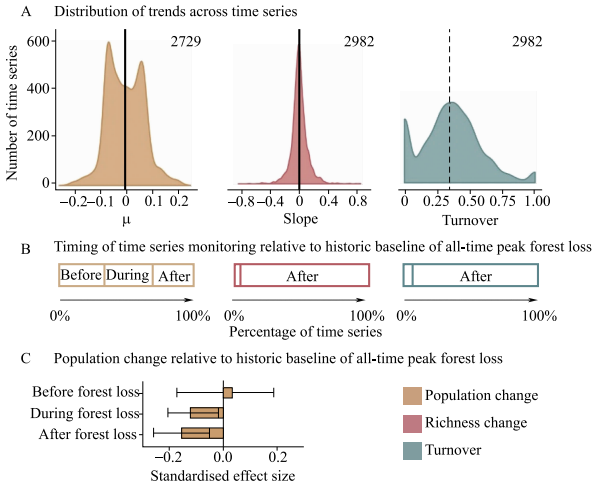
图 9-20　例 1[①]

① Kolorat S. R. R., Owenst G. L., Vazquez J. M., et al. Origins and evolution of extreme life span in Pacific Ocean rockfishes. Science, 2021,374,6569:842-847.



Astrocytes regulate myelinated axon excitability and conduction speed. For cortical neurons with myelinated axons crossing the corpus callosum (left), astrocytes regulate AIS excitability and axonal conduction speed (middle). Increases of astrocyte $[Ca^{2+}]i$ release ATP, which, after conversion to adenosine (Ado) extracellularly, activates A2aRs that raise the intracellular cyclic AMP concentration and thus generate an inward current through HCN2 channels in the AIS and nodes of Ranvier (right). Image was created with BioRender.com.

图 9-21　例 2[①]



Heterogeneity in population and biodiversity trends and land-use histories from sites around the world. (A) All three metrics of ecological change (population change, richness change, and turnover) show heterogeneous distributions across sites. (B) Population monitoring occurred at different time periods relative to all-time peak forest loss (for 33% of sites before, for 37% during, and for 30% after), whereas biodiversity monitoring predominantly started after all-time peak forest loss had occurred (94% of sites). (C) Population declines were more acute when all-time peak forest loss occurred during the population monitoring period (slope = −0.007, CI = −0.012 to −0.001; see table S2 for model outputs). Low sample size for the "before" (101) and "during" (38) categories precluded a similar analysis for richness change and turnover. Lines in (A) denote zero (solid) and mean values (dotted). Numbers in (A) show sample size (i.e., number of time series).

图 9-22　例 3[②]

① Lezmy J., Arancibia-CÁRCAMO I. L., Quintela-LÓPEZ T., et al. Astrocyte Ca^{2+}-evoked ATP release regulates myelinated axon excitability and conduction speed. Science, 2021, 374, 6565.

② Daskalova G. N., Myers-Smith I. H., Bjorkman A. D., et al. Landscape-scale forest loss as a catalyst of population and biodiversity change. Science, 2020, 368(6497): 1341-1347.

（三）*PNAS*[①]

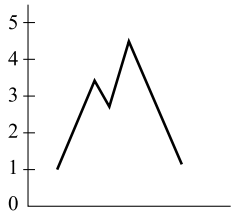
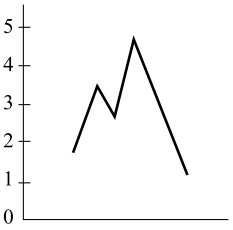
1. 制图要求

（1）对于表格的要求是：

—*Ensure that the table is in an editable Word, RTF, or LaTeX format.*（表的格式）

—*Include a brief title (above) and footnotes (below) the table.*（标题和脚注）

—*Avoid multipart tables (Table 1A, Table 1B).*（避免使用多部分表）

	Raster	*Vector*
Definition	*Images composed of pixels (alsocalled "bitmapped" or "pixelmapped" images). Use for non-line art images, e.g., scanned artwork, digital photographs, complex imagery, and color effects such as blended colors, shading, shadows, and gradients.*	*Images composed of paths (points, lines, and curves) that are created with mathematical formulas. Use for line art images, e.g., graphs, polygons, logos, illustrations, circles, and ellipses, all predominantly composed of solid colors with sharp lines and contrasts.*
Sample	 *Notice pixelation and blurriness ofnumbers, and jagged edges of lines. For details, magnify image by using zoom function.*	 *Notice continuous smooth paths of numbers and lines. For details, magnify image by using zoom function.*
Resolution	*—Graphics are resolution dependent; scaling to different sizes results in quality loss.* *—Images with large dimensions will maintain large file sizes.*	*—Graphics are not resolution dependent; they can be scaled to any size without quality loss.* *—Images with large dimensions will maintain smaller file sizes.*
File types	*—JPGs, GIFs, TIFs, and EPSs/PDFs originating from raster programs.* *—Common programs: Adobe Photoshop, Corel Painter, SketchBook Pro, and GIMP.*	*—AIs, and PPTs/EPSs/PDFs originating from vector programs.* *—Common programs: Adobe Illustrator, Corel DRAW, Sketch, PowerPoint, and Canva.*
Requirements & Tips	*—300 ppi for grayscale or color images with no type or lettering, 600—900 ppi for grayscale or color images with type, and 1000—1200 ppi for line art, e.g., bar graphs.* *—Color mode should be RGB.* *—Avoid creating text in graphics.* *—Raster-based files can have low resolution in the published article, as they cannot be altered in size without losing quality.*	*—300 dpi for grayscale or color images with no type or lettering, 600—900 dpi for grayscale or color images with type, and 1000—1200 dpi for line art, e.g., bar graphs.* *—Color mode should be RGB.* *—Best for creating text in graphics.* *Vector-based files provide maximum flexibility for sizing your figures, as they can be altered in size while maintaining high-quality resolution.*

① https://www.pnas.org/authors/submitting-your-manuscript

(2)对于图形的要求是：

—*PNAS strives to ensure articles are accessible for readers throughout the world by offering article PDFs that are easily suitable for downloading in any environment. In order to accommodate size and content, article PDFs are processed to display images at 200 ppi, which will guarantee quality at print size. The HTML display of an article offers 300 ppi for all images. In addition, the option to enlarge each figure and table in the HTML display is available to closely review comprehensive details, as necessary.*（图形像素）

—*Provide all images at final size.*（图形尺寸）

• *Small: approximately 9cm×6cm*

• *Medium: approximately 11cm×11cm*

• *Large: approximately 18cm×22cm*

—*Ensure that all numbers, letters, and symbols are no smaller than 6 points (2 mm) and no larger than 12 points (6 mm) after reduction. Keep text sizing consistent within each graphic.*（文本大小）

—*Preassemble all composite figures.*（合成图形）

—*Submit images in these file formats: TIFF, EPS, PDF, or PPT.*（文件提交格式）

—*Submit 3D images as either PRC or U3D. For each 3D image, include a 2D representation in TIFF, EPS, or PDF format.*（3D 图形提交格式）

—*Figure legends*

• *Include figure legends immediately after referencing the figure in the manuscript. Ensure that figure legends adhere to the following guidelines:*（图表说明需遵循的原则）

• *For figures with multiple panels, the first sentence of the legend should be a brief overview of the entire figure. Explicitly reference and describe each panel at least once in the figure legend.*（图形引用和描述）

• *Include clearly labeled error bars in all graphs and describe them in the figure legend.*（误差条）

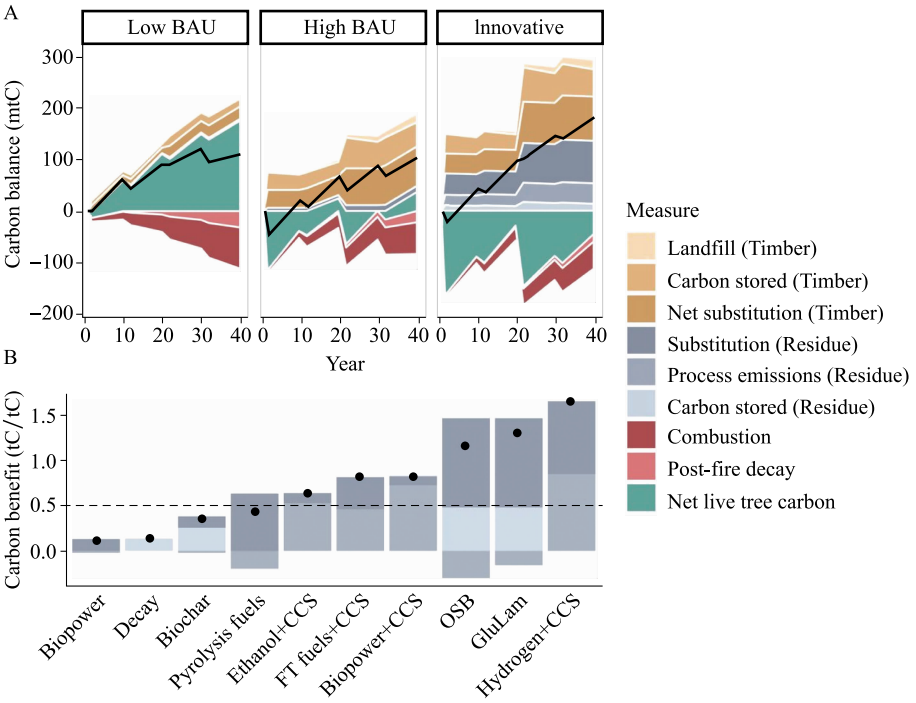
• *State whether a number that follows the ± sign is a standard error (SEM) or a standard deviation (SD).*（说明标准误差与标准偏差）

• *When applicable, provide the P value, magnification, or scale bar information.*（提供 P 值或比例尺信息）

• *Indicate the number of independent data points (N) represented in a graph in the legend.*（表示独立数据点的数量）

• *Ensure that numerical axes on all graphs go to 0, except for log axes.*（所有图形的数值轴都为零）

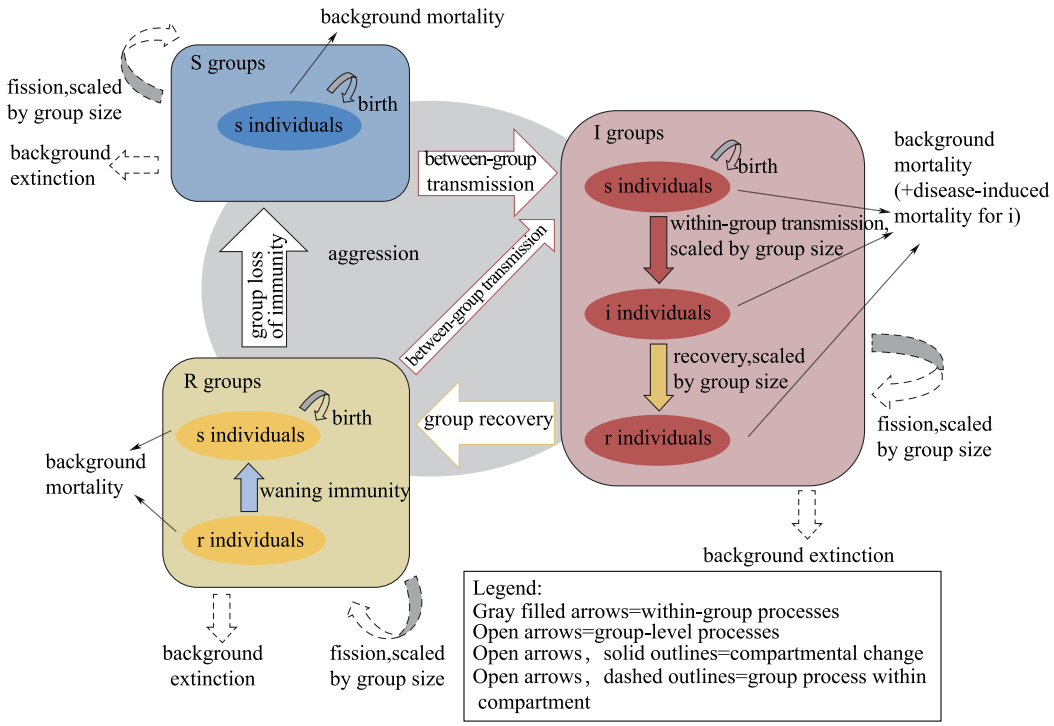
2. 案例欣赏



Life cycle, forest carbon balance across (A) three scenarios and (B) several technology pathways. Net carbon values are represented by dots in Band black lines in A. In B, the dotted line represents the threshold used to select the suite of technologies in IWP. Net live-tree carbon values are relativeto carbon stocks in year zero, and large decreases are associated with harvest events. In Low BAU, we model management only on corporate land where-potentially profitable (net revenue > $ 2,500/ha). In High BAU, we model management wherever it is net revenue positive with a delivered residue price of $ 0. In Innovative (IWP), we model management wherever it is net revenue positive with a delivered residue price of up to $ 100/ODT. The treatment areaunder IWP defines the study area for High and Low BAU, which include untreated forest.

图 9-23 例 1[①]

① Cabiyo B., Fried J. S., Collins B. M., et al. Innovative wood use can enable carbon-beneficial forest managements in California. PNAS, 2021,118(49):e2019073118.



Flow diagram for the SIR groups model. Boxes represent the three group compartments, and ovals within the boxes represent the mean number of individuals in each compartment within their respective group. Group-level processes are denoted with open (unfilled/white) arrows; if the arrow outline is solid, the group transitions to a different compartment (e.g., S to I); if the arrow outline is dashed, the process occurs in groups in that compartment (e.g., I group fissions and creates more I groups). Filled arrows represent within-group processes (e.g., i individual recovers to r). Intergroup aggression is an underlying process that is primarily driven by the number of groups, and it effectively controls pathogen transmission rates because it is the only form of intergroup contact in these models (i.e., $\beta B = \beta W * a$). Infected and recovered individuals can also contribute to new susceptible individuals through birth, but these arrows are not included for simplicity.

图 9-24　案例 2[①]

借助图表形式关键在于向读者展示论文的研究思路与主要结果。基于以上 Nature、Science 和 PNAS 关于图表要求的展示以及案例欣赏，可以感知不同权威期刊在图表绘制方面所存在的要求差异了。初学者能够了解到图表绘制所应该达到的极致水平，在长期的耳渲目染下，进一步丰富自己的制图技巧。并学会举一反三，在目标期刊没有具体要求的情况下，可以遵循哪些基本制图要求，体现出图表的准确性、科学性以及逻辑性。

① Brandell E. E., Dobson A. P., Hudson P. J., et al. A metapopulation model of social group dynamics and disease applied to Yellowstone wolves. PNAS, 2021, 118(10): e2020023118.

第三节　选择恰当图表形式

一、图表优劣与互换

图表各有优劣。在呈现研究结果、传递关键信息时，需要作者在版面有限的情况下，综合考量选用哪种形式更合适。因此在图表设计过程中，需要明确两个问题：一是通过图表想要传递什么信息？希望达到什么样的表达效果？二是图、表、文字哪一种表达方式更有效，可以更好的帮助读者思考数据的本质和规律。表 9-2 对图表的优劣进行了简要对比。

表 9-2　图表优劣对比

类型	优点	不足
图	侧重于表现关联、趋势、因果等关系。直观形象地显示目标要素的形态、位置、结构，反映数据的变化趋势、相互之间的关系等。若比较不同类别多采用柱状图；强调趋势变化时多采用线状图；展现各部分的构成比例时多采用饼状图；表示双变量和多变量的复杂关系时多采用点图；描述研究区地理位置、区位特征时多采用影像图；阐释研究思路、方法模型、概念框架时多采用示意图。	不能反映出原始数据，精确性不高。
表	侧重于数字、描述，倾向于数据的真实还原，用于翔实记录分析结果、原始数据或处理过的数据，显示数据精度，有助于解释计算过程、说明各个因素对结构数据的影响等，还可以再多个方向和多种因素之间进行比较。	展示的数据不够直观，所要表达的特点不够鲜明。

下面以同一组数据为例，分别采用三线表（表 9-3）和堆叠柱状图（图 9-25）的形式呈现给读者。相信大家可以切身感受到不同形式所表达的侧重点的不同，与之对应的表达效果也是截然不同的。建议读者结合这两个图表的对比，进一步分析与思考，从而加深对图表在形式上优劣的理解。

表 9-3　三线表

ECOLOGICAL GROUP					
Station	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ
75U	91.3	5.3	3.2	0.2	0.0
75R	89.3	6.1	3.6	0.5	0.0
200R	69.3	14.2	8.6	6.8	1.1
500R	63.0	29.5	3.4	4.2	0.0
1000R	86.7	8.5	4.5	0.2	0.0

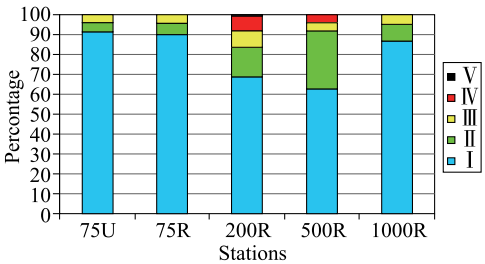


图 9-25　堆叠柱状图

二、图表引述

无论是采用什么类型的图表展示数据、研究结果，每一个图表都必须在正文中提及，并对图表所反映的关系或规律趋势等进行解释说明，或者是分析得出结论。图表正文引述方式可

以是如“*Figure* 5 *shows low water use* (2.5%) *for crop production*[①]”的形式，也可以是“*To determine the community perceptions of nexus resources, we used binary logistic regression* (*Table* 7) *and correlations* (*Table* 6)[①].”的形式。作者在论文撰写过程中可以根据表述需要灵活确定。

简言之，初学者在绘制图表过程中，要严格遵循目标期刊的要求，选择合适的数据组织形式：如果强调展示给读者精确的数值，就采用表格形式；如果要强调数据的分布特征或变化趋势，则适宜采用图示的形式。但一般的说，还应该注意以下方面：

(1)一定要避免以图和表的形式重复表述同样的数据，除非重复的理由十分必要。

(2)仔细考虑图表与文本之间的关系，确保图表中的信息内容、数据等与论文内容保持一致。

(3)尽可能地将论文贡献用关键性图表表达出来。文本中大量细节信息容易把贡献淹没，而不被读者快速发现和提炼出来。

(4)图表绘制时，虽然要考虑到完整性和重要性，但过于复杂的图表设计做法不足取。

三、撰写图表说明

当图表中需标注文字过多，或空间较小影响视觉效果时，为避免图表出现繁杂、拥挤、凌乱的现象，常以题注形式进行解释，即图表说明。一般置于图表下方。图表说明的内容通常是实验参数、符号、资料来源等的解释。图表说明在撰写过程中一般应遵循以下原则：

(1)独立原则。图表说明应独立成文，保证图表内容在不阅读全文的基础上可被全部理解，这也是照顾包括审稿人在内的读者的阅读习惯。

(2)扼要原则。关于图表说明的字数并没有明确限制，但是长篇大论的图表说明显然是不合时宜的。通常图表说明的字号比正文小，如果写太多内容的话，会降低阅读体验，甚至会遗漏重要信息。因此，图表说明一定要简明扼要、短小精悍。读者是可以在正文中找到的大量细节的内容，是不需要包含在内说明中的。如果使用缩写、符号等，说明中需要先给出定义后再使用。

(3)从无原则。理论上说，设计精当的图表是不需要任何图表说明的。图表本身已经足够传达必要的信息。所以，最好的图表说明就是没有图表说明。根据这个原则，即使没有图表说明，也要做到易于理解。

(4)匹配原则。图表说明与图表匹配，同时也要与正文匹配。前者侧重于表意的匹配，后者则是形式的关注。

如 *Global projections of future urban land expansion under shared socioeconomic pathways*[②] 中，作者采用雷达图展示五个不同情景下，预计到 2100 年因城市扩张造成的农田和粮食生产损失的变化情况(图 9-26)。在图表说明中，作者简要说明：与未来城市土地扩张造成的全球耕地面积约 1%的损失相比，全球作物生产的直接损失可能超过 1%，甚至可能高达 4%，具体取决于农作物类型。读者基于这一简要说明，可以更加直观的分析判断不同情景对应的城市扩张造成的水稻、小麦、玉米、马铃薯、蔬菜生产损失比例和农田面积变化趋势，还可以清

① Zinabu W., Wu W., Wang K. P., Haile K., Local community perceptions toward livelihood and water-energy-food nexus: A perspective on food security. Food and Energy Security. 2020,00:e207.

② Chen G Z, Li X, Liu X P, et al. Global projections of future urban land expansion under shared socioeconomic pathways, Nature Communications, 2020,(11):537.

晰的预判全球城市扩张对农作物生产的影响可能超过现有农田的损失。整体篇幅适宜，基本要素完整，精简清晰，对涉及到的符号进行了解释，传递了核心信息，对于初学者在以后的写作中有一定的学习借鉴意义。

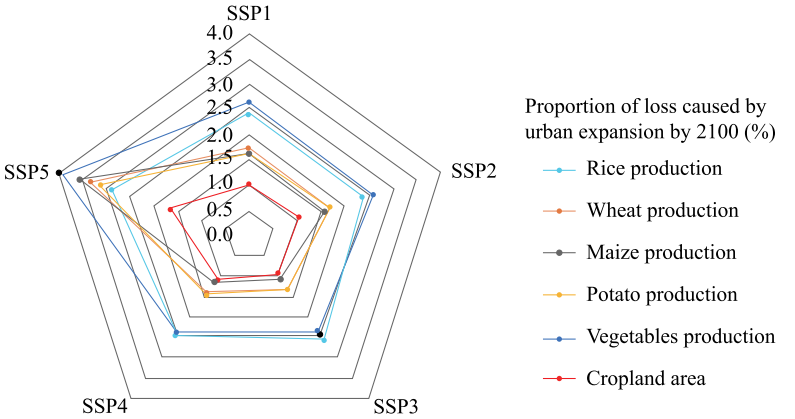


Fig. 8 Estimated cropland and food production caused by urban expansion by 2100. Comparing to the approximately 1% loss in the global cropland area caused by future urban land expansion, the direct losses of global crop production are likely to exceed 1%, and can even reach as high as 4%, depending on the specific crop types.

图 9-26　图注撰写案例示意

以上内容虽未涉及图表制作的具体操作方法、软件使用简介等内容，旨在结合案例帮助初学者了解到图表绘制时需要掌握的基本技巧和思路，明确图表绘制做到极致水平时应该是什么样的。使得初学者明了即使在目标期刊没有提供图表绘制具体要求的情况下，应该如何下手设计图表。推荐初学者在具体操作过程中，以发表论文中类似图表为范例，反复思量，选择出最能有效传达研究内容关键信息的表达形式。

第四节　思考与练习

一、课后思考

绘制图表是将艺术与科学相结合的工作。在准确、规范的基础上，可以融合作者自己的美学要求。我们无法穷尽所有的图表类型，主要是想通过这些顶级权威期刊的案例，向初学者展示图表绘制的大致情况，以便形成整体认知。

初学者在平时文献阅读过程中，可以通过不断积累，尤其是在反复看到前三节中提到的图表类型，能够完成以下思考：(1)所有这些图表类型你比较熟悉的有哪些？(2)哪些可以用到你的写作中？(3)这些图形之间有什么不同？(4)你知道这些图形分别适用于哪些情景？(5)如何绘制这些图形？(6)绘制出某一图形需要哪些类型数据与之对应？等。

此处，我们提供了一些图表案例，希望读者能够进行以下分析和思考：(1)对于同样一组数据，采用图和表哪种形式，更能实现论文作者预期的表达效果？(2)为什么采用图/表更合适？从而进一步掌握图表优劣。

Table 4. Major constraints of agricultural production in the highland as perceived by surveyed households *①

Constraints	Per cent of respondents
Scarcity of cultivated land	97
Soil fertility decline	87
Grazing land shortage	86
Soil erosion	81
Low fertilizer input	56
Erratic rainfall	57
Lack of improved seed	53
Pests and diseases	17
Inadequate extension services	23
Others	19

Note:*Percentages do not add up to 100 due to multiple responses.

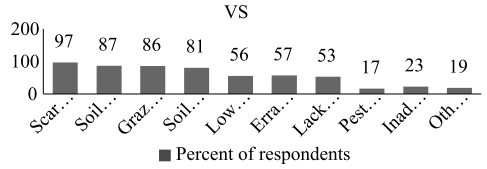


图 9-27　思考一：图表转换分析

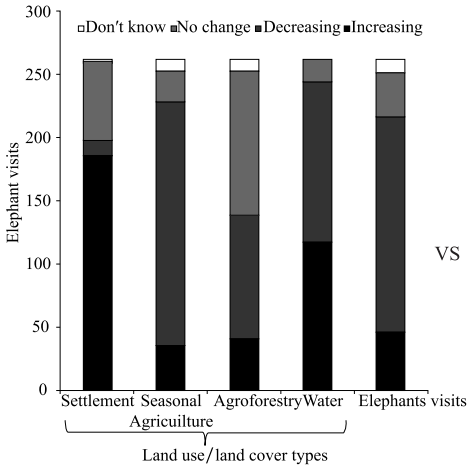


Figure 4. Perception of respondents towards changes in different land use/land cover (LULC) types and in the frequency of elephant visits over the last 6 years (N=261). ②

VS

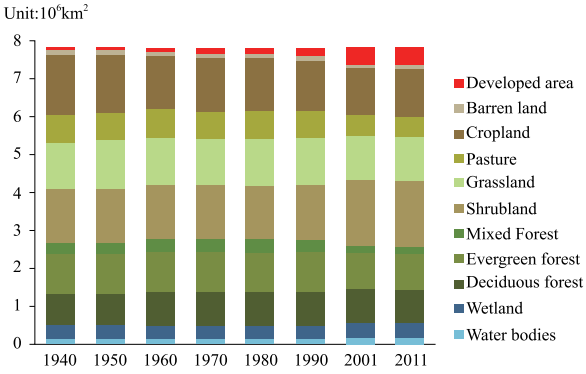


*Fig. 4. Areas of different land-use types across the conterminous United States from 1940 to 2011*③.

图 9-28　思考二：图形对比分析①

① EngdaworkAssefa, Hans-Rudolf Bork. Dynamics and driving forces of agricultural landscapes in Southern Ethiopia-a case study of the Chencha and Arbaminch areas. Journal of Land Use Science, 2016,11(3):278-293.

② Naza Emmanuel Mmbaga, Linus KasianMunishi, Anna Christina Treydte. How dynamics and drivers of land use/land cover change impact elephant conservationand agricultural livelihood development in Rombo, Tanzania, Journal of Land Use Science, 2017,12:2-3, 168-181.

③ Sun X, Tang H J, Yang P, et al. Spatiotemporal patterns and diverse of ecosystem service supply and demand across the conterminous United States: A multiscale analysis. Science of the Total Environment, 2020,703:135005.

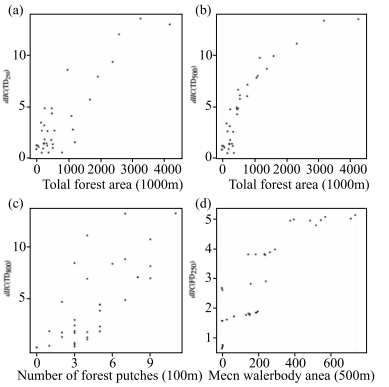


Figure 2. Most significant predictors of node importance for connectivity using taxonomic (TD) and functional diversity (FD) as node attributes for functional connectivity, along with different distance thresholds for amphibian dispersal of 250, 500 and 800 m: variation of node importance for connectivity using TD as node attribute for functional connectivity for the 250-m distance threshold with total forest area (1000 m) (a); variation of node importance for connectivity using TD as node attribute for functional connectivity for the 500-m distance threshold with total forest area (1000 m) (b); variation of node importance for connectivity using TD as node attribute for functional connectivity for the 800-m distance threshold with number of forest patches (1000 m) (c); and variation of node importance for connectivity using FD as node attribute for functional connectivity for the 250-m distance threshold with mean waterbody area (500 m) (d). ①

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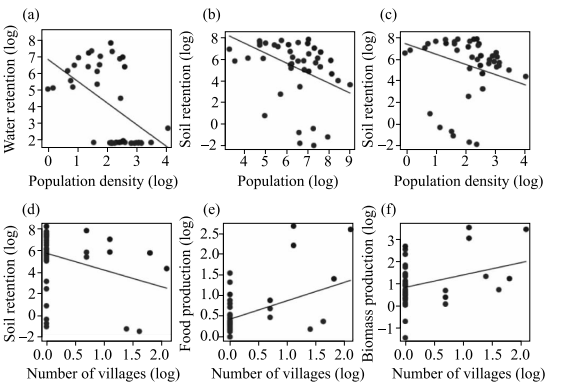

Fig. 5. Scatterplot showing only significant relationships ($p < 0.05$) between population variables and ES indicators: a) water regulation, b-d) soil retention, e) food production, and f) biomass production according to LMEs. Solid line represents fitted LME models. Hecho (green dots), Estercuel (red) and Monegros (blue) samplesare shown. ②

图 9-29　思考三:图形对比分析

① Ribeiro J, Colli GR, Soares A. Landscape correlates of anuranfunctional connectivity in rice crops: a graph-theoretic approach. Journal of Tropical Ecology, 2019,35,118-131.

② Bruno D., Sorando R., Álvarez-Farizo B. et al. Depopulation impacts on ecosystem services in Mediterranean rural areas. Ecosystem Services, 2021,52,101369.

通过以上思考，初学者应该对反复强调图表绘制的科学性、合理性、规范性、逻辑性等会有一个更深的理解和体悟。

目前到本讲止，保持作业完成进度的同学们应该已经明确了自己撰写论文中的研究方法部分，那么可以结合论文的研究内容、研究方法、数据特征等，根据目标期刊的要求，精心规划一下，需要采用哪些图表能够充分展现自己所想表达的内容，实现图表设计地科学、规范、简洁，布局合理，逻辑性强。

二、课后练习

通过以上理论了解和课后反思，最终目的是帮助初学者落实到实践中。只有实践，才可以真正掌握图表绘制技巧要领，做到内化于心、外化于行。大家不妨进行以下练习，来加深自己的认知和动手能力吧。

1. 筛选本领域高质量期刊论文 8～10 篇，认真研读这些文章中的图表，分析：

(1)作者为什么使用这一图/表？

(2)能否从这一图/表获取关键信息？

(3)如果这些数据使用其它类型的图/表，是否能够达到同样的效果？

(4)图表的内在逻辑关系是什么？

(5)哪些是你在图表设计过程中可以学习借鉴的？

2. 在具体绘制过程中，结合本讲介绍内容，落实到每一个细节，验证你所设计的图表。

(1)是否简单明确的传递了关键信息？

(2)是否存在重复表述？

(3)是否实现了图表的自明性？

(4)是否客观并能够突显出研究结果？

(5)图表之间内在逻辑关系是否清晰？