第七讲　如何写好引言

一个好的引言能够吸引更多的读者了解自己的研究。格言“*A bad beginning makes a bad ending*”说得好，指出了引言在某种程度上决定了一篇文献的成败。

第一节　概　述

一、何为引言

科学论文就是在讲“故事”。作为故事“开场白”的引言，要做到清新脱俗、引人入胜。

从方便读者出发，作者需要在引言中，交代清楚整篇文章的定位和研究目的的重要性。从期刊编辑和审稿人要求出发，作者需要在引言中回答以下问题：本文是否具有重要的理论价值和实践意义？研究内容是否足够新颖？论文是否满足期刊发表要求？考虑到以上要求，引言写作业已形成了相对固定的写作格式。在了解这一相对固定写作格式之前，让我们先来看两个实例。

1. *A multi-scenario ensemble streamflow forecast method for Amu Darya River Basin under considering climate and land-use changes*[①]

> *Hydrological models have been widely used for simulating hydrological processes and responses at various scales and regions, which use input parameters and refined mathematical models to simplify the natural hydrological processes (Abbaspour et al., 2015, Liu et al., 2017, Li et al., 2017, Woldesenbet et al., 2017). For most hydrological models, climate and land-use changes can greatly affect the accuracy of parameters, and these changes are also* ***the two most critical influencing factors*** *in the hydrological cycle (Ahiablame et al., 2017, Mekonnen et al., 2018, Chen et al., 2020). Climate change directly affects evaporation and streamflow recharge, and land-use change also balances the processes of interception, surface streamflow and groundwater replenishment (Yira et al., 2016, TorabiHaghighi et al., 2020). Complex interaction between climate and land-use changes may accelerate or slow down the hydrological processes together or separately, which makes streamflow simulation more difficult (Marhaento et al., 2018). Therefore, assessing the impacts of land-use and climate changes on hydrological processes is desired for identifying the potential magnitude of these changes as well as improving streamflow simulation and/or forecast accuracy.*

① Xu, Z. P., et al., A multi-scenario ensemble streamflow forecast method for Amu Darya River Basin under considering climate and land-use changes. Journal of Hydrology, 2021. 598: p. 126276.

该文首段以水文模型的应用和特点为背景引入，收敛到影响水文模型精度的因素，进一步提出气候变化和土地利用变化对水文模型及水循环具有重要影响，随之提出开展气候变化和土地利用变化分析对提高水文模型预测精度的必要性。本段紧扣主题，把研究背景和意义阐述得十分清楚。文中加粗下划线部分直接点题，简明扼要。请注意学习这种写法。

Previously, *a number of research works were conducted for investigating the impact of climate change on hydrological processes in a number of river basins, such as Yangtze River Basin (Su et al., 2017), multiple river basins in California (Grantham et al., 2018, Mallakpour et al., 2018), Indus Basin (Hassan et al., 2019), Ashuelot River Basin (Wang et al., 2020), and Qu River Basin (Gao et al., 2020a). In these studies, global climate model (GCM) is useful for simulating climate change (Vetter et al., 2017, Kang et al., 2019, Wang et al., 2019a, Lee et al., 2019). Due to the complexities of GCM in terms of parameter estimation and model structure, there are many uncertainties (e.g., differences caused by various boundary conditions and driving factors) in the processes of regional climate simulation (Zhuang et al., 2018, Mei et al., 2020). The impacts of uncertainties cannot be ignored when using a single GCM, while multiple GCMs can provide a more reliable climate prediction and reduce the deviation between simulation scenarios and actual conditions (Wang et al., 2018, Noor et al., 2019).* ***A number of studies have been undertaken to proof that*** *multiple GCMs can effectively improve the accuracy of climate simulation and have achieved satisfactory results (Zhuang et al., 2016, Zhang et al., 2016a, Tegegne et al., 2019).*

第二段从“Previously”一词不难看出，本段开始了研究综述：从介绍前人在气候变化对水文过程影响方面已完成的一些工作，引出全球气候模型（GCM）；接着通过引用文献，指出GCM的特点，证明相较于单GCM模型（a single GCM），多GCM模型（multiple GCMs）模拟效果更好；最后一句话予以总结。是典型的三段式逻辑结构。

Hydrological processes are affected ***not only by climate change***, ***but also by land-use change***. *Over the past decades, numerous research works have revealed the effect of land-use change on hydrological processes (Zhang et al., 2016b, Anand et al., 2018, Li et al., 2019, Williamson and Claggett, 2019, Luo et al., 2020). Cellular Automata-Markov (CA-Markov) model is widely used for simulating the land-use change scenarios, which is composed of Markov Chain model and Cellular Automata (Fu et al., 2018, Zhao et al., 2019, Gomes et al., 2020, Yulianto et al., 2020). Markov Chain model uses the starting and transferring probability of each state to forecast land-use, but the prediction ability in the spatial dimension is weak (Gong et al., 2019). Cellular Automata (CA) is a local grid dynamic model which can decompose the research area spatially (Gao et al., 2020b). Combining the two models, CA-Markov has advantages in quantitative prediction and simulation of spatiotemporal change (Gong et al., 2019). Fu et al. (2018) cou-*

pled CA-Markov model with Multiple Criteria Evaluation (MCE) to simulate land-use change, and the predicted results had a great fit with the measured data. Zhao et al. (2019) evaluated the impact of ecological engineering on carbon storage in the upper reaches of the Heihe River by linking the CA-Markov model and Integrated Valuation of Ecosystem Service and Tradeoffs (InVEST) model; the results showed that the performance of the method is satisfactory due to the low relative error. Yulianto et al. (2020) used the CA-Markov model to accurately predict future land-use change in the upper Citarum River Basin (Indonesia). Through using land-use data predicted by CA-Markov model and climate data simulated by GCMs as inputs, the future streamflow of the river basin can be precisely predicted based on Soil and Water Assessment Tool (SWAT) model. The SWAT model is a typical process-based hydrological model, which can achieve the reliable hydrological simulation and provide the physical description of hydrological processes (Liu et al., 2020). Generally, most of previous studies effectively considering individual impact of climate change or land-use change on hydrological processes, where climate variation and human activities have been studied as important influencing factors of the hydrological cycle (Villamizar et al., 2019, Aboelnour et al., 2020, Hung et al., 2020). ***Few studies*** *integrated CA-Markov model, multi-GCMs and SWAT into a general framework to simulate land-use and climate conditions and to analyze hydrological response.*

第三段通过采用"**not only, but also**"句式完成了开场白，不仅引出另一重要影响因素"**land use change**"，与第一段中"**the two most critical influencing factors**"和第二段中"**climate change**"遥相呼应，逻辑严密；并且标示出本段同样是研究综述，尤其侧重于土地利用变化影响方面的综述。不难发现，本段采用了和上一段相同的逻辑结构，完成了文献综述：认可了以往研究中对气候变化和土地利用变化影响的考虑；同时认为已有研究很少有将 3 个模型（上段 multi-GCMs、本段 CA-Markov 及 SWAT）集成在一个框架中进行的分析；最后一句话通过采用"**Few studies**"引出总结。

①The Amu Darya River is located in Central Asia, originating from the Pamirs and the Hindu Kush Mountains (Sun et al., 2019). ②The river is mainly replenished by the alpine glacial melt water and the rainfall. ③Climate change has the obvious impacts on glaciers and precipitation, which can further affect river streamflow processes. ④The Amu Darya River flows through arid and semi-arid climate regions, and water for irrigation and other purposes mainly comes from the river. ⑤With the development of economy and society, the trend of over-utilizing the water of the Amu Darya River is gradually deepening. ⑥Several researchers paid attentions to the factors affecting water resources of the region and separately studied the impacts of climate and irrigation activities on streamflow changes (Baidya Roy et al., 2014, White et al., 2014, Duan et al., 2019, Su et

al., 2021). ⑦***Unfortunately, no previous study*** *was reported on simultaneously examining the effects of human activity and climate change on the river's streamflow through integrating CA-Markov model, multi-GCMs and SWAT within a general framework.*

第四段既是介绍研究区(句①)及其基本特征(句②～⑤),又是强调研究的 knowledge gap(句⑥～⑦)。其中,句⑤旨在强调研究区的典型性。句⑥综述出(several researchers)该区研究现状及主要问题(separately studied)。最后一句,句⑦通过采用"**Unfortunately**"开头,加上"**no previous study**"对 knowledge gap 进行了总结。虽然表述"integrating CA-Markov model, multi-GCMs and SWAT within a general framework"与上一段最后一句总结存在重复之"嫌",但也可以认为是通过重复以示"强调"。

①*Therefore, this study aims to develop a multi-scenario ensemble streamflow forecast (MESF) method for analyzing future streamflow of the upper Amu Darya River Basin under considering land-use and climate changes.* ②*MESF will incorporate CA-Markov model, multi-GCMs and SWAT within a general framework.* ③*In MESF, CA-Markov model will be used for predicting land-use scenarios, multiple GCMs will be used as future climate change scenarios, and SWAT will be used to simulate the streamflow processes under various scenarios.* ④*Then, the streamflow processes under each scenario will be compared and analyzed to evaluate the possible variation ranges and impact factors of future streamflow.* ⑤*The advantages of MESF are: (i) it can simultaneously examine the effects of land-use and climate changes on the river's streamflow; (ii) based on multiple scenario analysis and ensemble forecast, it can generate a range of possible streamflow that can reflect the trend of future streamflow change; (iii) by setting extreme scenarios, it can assess the impact of key factors (e.g., glacier area) on streamflow.* ⑥*The MESF method is applied to the upper reaches of the Amu Darya River Basin in Central Asia where the impacts of human activities and climate changes are urgent to reveal.*

本段是引言最后一段。句①明确了论文的贡献,即提出了 MESF 模型。句②～④是对 MESF 模型的介绍,即与上一段 knowledge gap 呼应。句⑤是对 MESF 模型优点的介绍。句⑥强调了研究的应用价值。

2. *Land use changes in the coastal zone of China's Hebei Province and the corresponding impacts on habitat quality*[①]

The coastal zone is a transitional and interactive zone between the terrestrial and marine ecosystems. It contains various natural resources, but its ecosystems are relatively fragile (Chuai et al., 2015; Riedler and Lang, 2017; Small and Ni-

① Zhang X, et al. Land use changes in the coastal zone of China's Hebei Province and the corresponding impacts on habitat quality. Land Use Policy, 2020, 99: 104957.

cholls, 2003; *Yanes et al.*, 2018). *Since the 21st century, alongside the continuous global extension of human activities from land to sea* (*Liu et al.*, 2014*a*; *iu et al.*, 2018; *Pramanik*, 2016), *more than* 40 % *of the population has become concentrated in regions less than* 100 *km away from a coastline* (*Bao et al.*, 2019; *Intergovernmental Oceanographic Commission of UNESCO* (*IOC et al.*, 2011). *China's coastal zone areas account for* 15 % *of its total land area* (*Guo et al.*, 2011; *Wang et al.*, 2014). *With the intensification of human activities, the strong aggregation of the chemical industry, and accelerating urbanization, the land use patterns of the coastal zone have significantly changed, with a deterioration in the ecological environment and biodiversity of the coastal zone* (*Ma et al.*, 2014; *Long et al.*, 2009; *Song and Deng*, 2017; *Song et al.*, 2015). *Therefore, it is of great significance to investigate land use changes and assess the corresponding influences on habitat quality in China's coastal zone. This would provide rational guidance for land use and development, and protect the ecological environment of the coastal zone.*

这是一篇主题为海岸带土地利用变化及其对生境质量影响的论文。作者开宗明义,以海岸带定义及其在全球范围内的重要性为背景作为起始句。接着插入中国沿海地区这一案例。通过两句话高度概括的介绍,即占土地总面积的15%,以及土地利用格局的显著变化和生态环境与生物多样性退化。之后直奔主题,强调了研究的必要性和重要性。

①*Because of the specific geographic location of coastal zones, with their multiple interactive interfaces, land use changes in these areas have become a research hot spot* (*Liu et al.*, 2018; *Turner et al.*, 1998). ②*Remote sensing image recognition can be used to investigate the spatio-temporal variation in land use changes in the coastal zone* (*Han et al.*, 2016). ***For example***, *Berlangarobles and Ruizluna* (2002) *identified the land use changes in the coastal zone in Mexico from* 1970 *to* 1997 *based on Landsat Multispectral Scanner* (*MSS*) *images and Thematic Mapper* (*TM*) *images. Similarly, Rojas et al.* (2019) *identified the land use changes in the Concepción metropolitan area from* 2004 *to* 2014 *and analyzed the changes in wetland areas using TM images. It was found that urban expansion was the main reason for wetland loss in coastal zones. In addition, some researchers have used high-resolution images to investigate land use changes in coastal zones, including Tran et al.* (2019), *who extracted the land use changes of the northeastern region of BinhThuan in the mid-southern coastal zone of Vietnam using WorldView2 high-resolution remote sensing images from* 2011 *and GeoEye1 data for* 2016. *They found that the water area in the mid-southern coastal zone of Vietnam had decreased considerably.* ***Although*** *many researchers have investigated land use changes in some coastal zones using medium-or high-resolution remote sensing images,* ***these researches have generally considered short-term*** *land*

use changes because of the ***lack of long-term remote sensing data.***

第二段句①点明本研究是一个热点问题。句②非常重要，直接把热点问题收敛到论文研究方向，为综述埋下伏笔。紧接后面的“**For example**”很好的说明了这一点。尾句以**Although**开头，具有强烈的总结和引出 knowledge gap 之意，并将之充分的体现在“short-term”和“lack of long-term”两个词/短语上。

Land use change is an important impact factor threatening habitat quality (Kim et al., 2015; Mendoza-González et al., 2012; Yu et al., 2016; Liu, 2018; Chisholm et al., 2018; Guida-Johnson and Zuleta, 2013; Song and Pijanowski, 2014). ***Previous studies*** *have mainly investigated the influences of land use changes on habitat quality* ***from micro and macro perspectives.*** ***At the micro-level****, it is difficult to directly investigate the influences of land use changes on habitat quality. Therefore, biodiversity is considered to be the indicator that can best reflect habitat quality (Debano et al., 2016; Riedler et al., 2015; Barragán and Andrés, 2015). Previous researchers have mainly analyzed the influences of land use changes on the biodiversity of animals and plants (such as spiders, bees, fishes and aquatic invertebrate) and plant communities (such as vascular plant, liverwort and mosses) (Delalieux et al., 2012; Grant et al., 2018; Jantz et al., 2015; Kyle et al., 2016; Lammert and Allan, 1999). It has been found that land use changes can affect the division and distribution of herb plant species and woody plant species (Hermy and Verheyen, 2007; Tim et al., 2015). For example, land use changes can cause changes in the landscape structure and habitat quality, leading to an alteration in plant species diversity (such as weed species and plant communities) (Baessler and Klotz, 2006; Etienne et al., 2010). On the other hand, land use changes can alter the adaptability of animals to a certain habitat; thus, affecting animal diversity (Lienert, 2004; Nakahama et al., 2018; Uden et al., 2015; Xu et al., 2018). For example, Otto et al. (2016) confirmed that certain land use changes reduced the adaptability of bees to their habitat in North and South Dakota, USA; thus, affecting the population number. Many of these studies have been based on field measurements, which are time-and labor-consuming and* ***can be difficult to*** *conduct* ***in large areas*** *due to* ***the lack of*** *temporal and spatial continuity.*

第三段是论文另一主题（土地利用对生境质量影响）的研究综述。首句虽没有继续指出这个主题也是研究热点，但通过引用 7 个文献和从 2012～2018 年的时间跨度，间接例证出研究热点这一论点。继而通过使用“**Previous studies**”引出综述。该句很简短，但提供了一个重要信息，即“**from micro and macro perspectives**”（分类）。其后紧接“**At the micro-level**”开头。另外，在第四段段首还可以看到“**At the macro-level**”。说明第三段和第四段在逻辑上是并列关系，并分别从这两个视角进行文献综述。本段尾句出现的三个词/短语（difficult、in large areas 和 due to the lack of），很好地对“At the micro-level”视角的 knowledge gap 进行了总结。

At the macro-level*,* ***most studies*** *have explored the impacts of changes in the*

spatial pattern of land use on the regional habitat quality. ***Researchers usually*** *directly couple land use changes with habitat quality models to assess the influence of land use changes on habitat quality (Chu et al., 2018; Hu et al., 2017; Miguel et al., 2018; Roman et al., 2018; Svoray et al., 2005; Xie et al., 2018; Yan et al., 2018).* ***For example****, Mushet et al. (2014) assessed the changes in amphibian habitats under different land coverage conditions in the Prairie Pothole region of North America. They found that the degradation of habitat quality in this region was mainly due to the transition from grassland to cultivated land. Similarly, He et al. (2017) simulated the future habitat quality under different scenarios in the Wanzhou District of Chongqing, China. They found that habitat quality degenerated under a scenario with rapid urbanization, while the opposite trend was observed in a scenario in which ecological protection measures were taken.*

如上所述,第四段是宏观视角下的文献综述。段中出现的"**most studies**"、"**Researchers usually**"和"**For example**"等词语即是佐证。但是与第三段不同的是,在段尾并没有看到总结性语句。从结构诊断来看,此处是可以添补一句总结句的。

Several studies *have focused on land use changes in the coastal zone and on the impacts of land use changes on habitat quality.* ***However****, two areas have not been well investigated.* ***First****, due to the lack of long time-series remote sensing data, the long-term land use changes in coastal zones have largely been neglected.* ***Second****, quantitative assessment methods have rarely been used to clarify the contributions of changes in land use to changes in habitat quality. We therefore coupled a topographic map with remote sensing images to identify the land use changes in the coastal zone of Hebei Province (CZHP) in the past 70 years, and assessed the influences of land use changes on habitat quality using the InVEST model. The aims of the study were to:* **1)** *reveal the land use spatio-temporal pattern in the CZHP from 1950 to 2017;* **2)** *assess the spatio-temporal change and degree of habitat quality degradation in this region; and* **3)** *determine the contribution of land use changes in the coastal zone to changes in habitat quality.*

最后一段中首句通过使用"**Several studies**"开始了总结;随后使用"**However**"作为起始词,指出了两个 knowledge gaps,并使用"**First**"和"**Second**"清晰的区别出来。之后给出论文的研究内容及研究目的,其中研究目的还特别采用"**1)、2)和 3)**"的数字标示方式标注出来。

细心的读者会发现,以上两篇文献在一定程度上是有差别的。首先,期刊 Journal of Hydrology(SCI)与 Land Use Policy(SSCI)学科属性不同。其次,两篇论文从创新性看,一篇侧重构建一种新的方法,一篇强调填补某一认知上的空白。尽管如此,通过对比分析,依然可以发现,引言具有十分明晰的逻辑,格式相对固定。即,包括背景介绍,前人相关研究的历史、现状、不足和局限性,研究目的、理论依据、所作假设、拟解决的科学问题,以及研究区的特征和选择依据等。当然,上述内容并不是必须同时存在的。如例 2,引言部分并没有对研究区进行介绍,而是放置在了论文第二部分(The study area and data sources)中。

二、基本要求

了解了引言构成之后，先不要急于下笔。正所谓“磨刀不误砍柴工”，整体把握引言写作的基本要求，会使我们在写作过程中更加得心应手。

1. 语言简明扼要。大部分科学论文对文章的篇幅都有要求（具体视期刊而定）。过于冗长的文字容易使读者失去兴趣。引言作为论文的“门面”担当，核心任务就是，以最简明扼要的语言将研究主题的来龙去脉表述清楚，让读者有读下去的欲望。

2. 内容详略得当。引言在内容架构上，要繁简适度。研究背景、常识性概念等，只需精炼语言进行总结即可，不需要展开讨论。在对研究进展总结评价时，要有选择地使用篇幅。如例1，论文侧重于方法，所以在论述气候变化和土地利用对水文过程的影响时，寥寥几笔带过，仅使用了一些代表性文献进行佐证。但是涉及到模型以及讨论其优点与可靠性时，使用了大量篇幅。

3. 表述准确清楚。科学论文在表达时，要符合学术语言规范。涉及科学问题时，在概念、观点以及定义等描述上，一定要准确。使用的数据也要确保其准确性，必要时要通过引用文献加以佐证。为便于读者阅读，涉及一些专业术语时，有必要给予定义或解释。缩写词也应当在首次出现时给出完整拼写。

第二节　撰写引言

一、写作步骤

在对目标期刊的要求有了基本的了解的前提下，再开始着手撰写科学论文，这有利于论文投稿程序的顺利进行。初学者在开始引言部分写作之前，应通过阅读目标期刊中的作者指南了解到具体要求。表7-1列举了部分SCI期刊对引言撰写的要求。尽管四个期刊都要求引言部分必须交待研究背景和目的，但细节上仍有所区别。相较于专业性期刊，综合性期刊更希望能够从大背景出发，方便其它学科读者的理解与认同。

表7-1　部分期刊作者指南中的引言要求

期刊	学科领域	Top	IF 2022	要求
Science Advances	综合性期刊	是	13.6	*The Introduction clearly identifies the purpose and scope of the research presented in the article, and details the scientific question being investigated. Any necessary background information should provide context to readers in other disciplines to ensure that the implications of the experimental findings can be understood by researchers outside the authors' area of research.*
Ecology Letters	环境科学与生态学	是	8.8	*The introduction should summarize briefly the background and aims, and end with a very brief statement of what has been achieved by the work.*
Ecosystem Services		否	7.6	*State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.*
Journal of Applied Ecology		是	5.7	*This should state the reason for doing the work, the nature of the hypothesis or hypotheses under consideration, and should outline the essential background.*

注：以上资料来源为各期刊官方网站

论文撰写时要符合目标期刊要求，但是目标期刊不止一个。因此，我们要了解期刊的共性要求，做到“心中有数”，知道大概要按什么样的步骤和框架去架构它，即逻辑思路一定要清晰：引言应该有几个部分、每个部分大致有几段、每一段写什么内容比较合适、先写什么后写什么等，做到由简至繁，一步步细化。在这个过程中，一定要确保段落之间的逻辑性和层次感。一般来说，引言由 2～6 段组成，3～4 段为佳，最好不要超过 6 段。篇幅上来看，常规论文引言以一页左右为宜；Letter 的引言相应短一些，但也应在半页到一页之间为宜。

二、写作要点

比较常见的引言写作框架是“漏斗型”，即先从宽泛的研究背景出发，逐渐收敛到对研究目标进行阐述，这个过程遵循着“从一般到具体”的原则。完成“漏斗型”的引言写作，不妨先思考以下五个问题：(1)研究的问题及其背景是什么？(2)已有研究成果有哪些？(3)这些研究中，存在的缺陷和不足有哪些？(4)本研究的目标和方法是什么？(5)其研究价值是什么？当写作框架确定以后，就可以根据框架把文字填进去了。在这一过程中，按照回答上述五个问题的逻辑来组织语言，下笔的时候自然能够一气呵成。

(1)研究的问题及其背景

回答这个问题，需要向读者和审稿人阐述清楚论文的研究范围和背景，凸显出研究的重要性。简而言之，就是提出的研究主题是什么、为什么这个研究很重要、提炼的科学问题是什么。如果研究问题众所周知，简单交待清楚即可；如果研究问题专业性很强，则需要较多篇幅对问题进行详细解释。解释过程中，应考虑在第一段就提及一系列与主题有关的关键词(尤其是标题中出现的主旨关键词)，以确保没有跑题、偏题。当然，主旨关键词的反复出现，还会起到加深读者印象的作用。需要注意的是，所有关键术语或概念需要在引言起始部分就及时给出简明扼要的介绍或解释。一方面，使得非研究领域的读者能够更好的理解后文出现的一些相关概念或观点；另一方面，也避免一词多义，出现不必要的理解歧义。

以下将通过 2 个实例详细解析：

3. *Quantification of basin-scale multiple ecosystem services in ecologically fragile areas*[①]

> ①*The watershed ecosystem, which integrates the river and terrestrial ecosystems, is a complex system with strong integrity and marked spatial heterogeneity* (*Trimble*, 2004, *Ghermandi et al.*, 2009, *Theodoropoulos et al.*, 2010, *Cheng et al.*, 2014). ②*In* 1998, *the World Resources Research Institute first evaluated the value and vulnerability of the ecosystem services from the perspective of watersheds* (*Revenga et al.*, 1999). ③*Since then, several research achievements have considerably promoted the public's understanding of ecosystem services, and its concepts and methods have been gradually applied to the formulation of policies for ecosystem management* (*de Groot et al.*, 2010, *Bateman et al.*, 2013, *Aschonitis et al.*, 2016, *Cui et al.*, 2019, *Chen et al.*, 2020). ④*To quantify the water-*

① He S, et al. Quantification of basin-scale multiple ecosystem services in ecologically fragile areas. CATENA, 2021, 202: 105247.

shed ecosystem services, several scholars (Locatelli et al., 2011, Zhongyuana and Huaa, 2011, Trabucchi et al., 2012, Costanza et al., 2014, Wang et al., 2014) adopted the global ecosystem service value determined by Costanza et al. (Costanza et al., 1997, Costanza et al., 2014) and the Chinese ecosystem service value obtained by Xie et al. (2015). ⑤However, the results of these two methods are the average values of the global and national scales, respectively. ⑥Such average values are, to some extent, different from that of the basin-scale, and this difference is magnified in ecologically fragile areas, owing to the notable spatial heterogeneity. ⑦Therefore, to accurately evaluate the watershed scale ecosystem services, it is necessary to modify the quantification of the ecosystem services by using the downscaling method.(引言第一段)

句①以"*watershed ecosystem*"作为关键词引入,紧扣标题中的"*basin-scale*"。句②～③以流域尺度生态系统服务评价(*evaluated*)历史及研究成果的应用(*concepts and methods*)为大背景,突出量化的重要性。其中使用的关键词 *ecosystem services* 和 *watersheds*,与句①中出现的 *watershed* 和 *ecosystem* 逻辑一致。句④是量化方法综述,除了继续使用 *watershed* 和 *ecosystem services* 以外,还使用了 *quantify* 与之前出现的 *evaluated*、*methods* 逻辑上呼应。句⑤～⑥以"*However*"开头,意在提出 knowledge gap,其中关键词 *basin-scale*、*ecologically fragile areas* 与 title 一致,紧扣主题。句⑦指出了拟解决的科学问题,关键词 *quantification* 与综述句④对应。

此处写作难点是,如何表达出研究的重要性? 可以采用的方法大致有两种:一种是通过反面案例突显。即文中的综述呈现方法,即现有方法在流域尺度不适用,从而引出降尺度研究的必要性。另一种是正面说明。例如以下案例:

4. *Carbon emissions induced by land-use and land-cover change from* 1970 *to* 2010 *in Zhejiang, China*[①]

①Global warming is an international challenge facing humanity in the 21*st century (Wang et al., 2017). ②Since the last century, the average global surface temperature has risen by* 0.74 ℃ (95% *confidence interval*: 0.56－0.92 ℃) (*Cubasch et al.*, 2013). ③*At the end of* 2015, 195 *nations adopted the Paris Agreement under the United Nations Framework Convention on Climate Change* (*UNFCCC*), *which focused on limiting the increase in the global temperature to less than* 2 ℃ *above pre-industrial temperatures* (*Talks*, 2015). ④*Climate models indicate that it is still possible to achieve, but efficient and sustainable policies relating to low-carbon emissions are required* (*Talks*, 2015).(引言第一段)

首段中,句①以全球变暖为大背景引入,指出研究是一个关乎全人类的全球性问题"*an international challenge facing humanity*",凸显重要性。句②用数据支撑了句①的观点,即

① Zhu E, et al. Carbon emissions induced by land-use and land-cover change from 1970 to 2010 in Zhejiang, China. Science of The Total Environment, 2019, 646: 930-939.

“地表温度上升了，全球在变暖”。既然全球变暖是一个世界性问题，那么如何应对？很自然地，句③给出答案，即签订“UNFCCC”。接着提出问题：这个公约能不能实现？句④的答案是，能，但需要实行碳排放相关政策支持。此处以“*but*”为转折，提出了主题词“*carbon emission*”。至此，研究碳排放的重要性已经呼之欲出。

①*Greenhouse gas emissions* (*GHG*), *especially carbon dioxide* (CO_2) *emissions*, *are considered to be the main drivers of global warming* (*Bamminger et al.*, 2018; *Cubasch et al.*, 2013; *Yu et al.*, 2017). ②*And the increase in atmospheric* CO_2 *concentrations has reached* 1.9 *ppm per year* (*Wang et al.*, 2016), *which has further exacerbated global warming*. ③*Land-use and land-cover change* (*LUCC*) *is a crucial source of carbon emissions* (*Intergovernmental Panel on Climate Change*, 2006) *and accounts for approximately one-third of the carbon emissions caused by human activities since the industrial revolution* (*Houghton et al.*, 2012). ④ *Due to the significant feedback of land systems to the atmosphere*, *an insightful evaluation of the interaction between LUCC and carbon emission is critical*.（引言第二段）

第一段中，文中虽然把问题从“*global warming*”收敛到“*carbon emission*”，但是，碳排放类型多样，还需要继续收敛，即将范围缩小到本文聚焦点上。因此第二段进行了如下的背景陈述：句①提出温室气体排放是全球变暖的主要驱动力，并用“especially”突出了碳排放对变暖的贡献。句②“*further exacerbated*”更进一步突出了研究碳排放的必要性。句③则通过碳排放引出本文的另一关键词“*Land-use and land-cover change*”，进而将研究范围缩小到“*Carbon emissions induced by land-use and land-cover change*”这个点上。句④除了通过锁定科学问题“*the interaction between LUCC and carbon emission*”，而且以“*Due to*”开头，连用“*significant*”、“*critical*”两个词，强化了研究的重要性。

与例 3 不同，例 4 通过采用层层递进的方式，铺陈出研究问题和背景。通过结构剖析可以发现，第一段尾句的主题词是 *carbon emission*；但第二段首句并没有接着 *carbon emission* 的逻辑继续；而是提出温室气体排放对全球变暖的影响。严格来说，这种衔接处理略显迂回。但是，瑕不掩瑜，好的地方仍值得借鉴学习。这也再一次提醒初学者，要时刻注意保持逻辑的一致性。

通过对比上述两个案例可以看到，反面烘托与正面陈述，都是可取的。但是中个差异，还需要读者细心体会，通过大量练习，慢慢积累经验，才能丰富并灵活运用各种写作技巧。

(2)已有研究成果及其 knowledge gaps

该部分是引言中最耗费笔墨的部分，但是又要求不能写流水账、长篇罗列。可以说，相当考验写作水平和对本领域学科发展动态掌握的熟悉程度。

一般的，该部分以总结最新研究进展为重点，概括前人针对讨论问题已经完成的工作积累，归纳出前人成果与本研究之间的关系，着重是提出存在的缺陷和不足，即 knowledge gaps，从而渲染出本研究的创新性。knowledge gaps 可以是对技术、数据、实验方案、方法和模型等进行的创新或改进；也可以是对物质、功能、机制、现象和规律等展开的深度或广度挖掘。

这一部分写作有两点需要注意：一是所有文献综述都应服务于研究的创新点。一些问题

研究的少，不意味着不值得研究。文献综述时，不能因为可供综述的文献较少而不写。二是对前人成果述评时，要实事求是，不能为了突出本研究的价值而贬低别人。

下面依然以例 3 为例，通过分析引言的第三段和第四段，讨论此部分的写作技巧：

①*Several researches attempted to establish a model that could simulate and predict the value of the ecosystem services*; *such attempts included the basin hydrological model*, *integrated valuation of ecosystem services and tradeoff model* (*InVEST*), *artificial intelligence for ecosystem services model* (*ARIES*), *and social values for ecosystem services model* (*SVESM*) (*Goldstein et al.*, 2012, *Bagstad et al.*, 2013). ②*In particular*, *the basin hydrological model applied to wetland loss and restoration scenarios could provide local estimates with the ecosystem service* (*ES*) *provision related to flood control and nutrient removal* (*Pattison-Williams et al.*, 2018). ③*Furthermore*, *several researchers focused on the function and service method*, *which could simulate the ES function in a small area by establishing the production equation between a single service function and the local ecological environment variable* (*Kareiva et al.*, 2003, *Robertson et al.*, 2005, *Costanza et al.*, 2014). ④*However*, *this approach involves several input parameters* (*water supply*, *electrical supply*, *production*, *tourism*, *atmosphere regulating*, *water reserve and flood prevention*, *pollution reduction*, *and biological habitat function*), *which complicates the calculation process*. ⑤*Moreover*, *it is difficult to unify the parameter standards of each service value*, *and thus*, *this method is not preferable*. ⑥*Although the abovementioned models make the quantification of the ecosystem services at the basin-scale feasible*, *these models often reflect only the main services*, *and because each method has a different emphasis*, *the limitations of the parameter adjustment may lead to inaccurate results*.（引言第三段）

首句的“*Several researches*”释放了这是一段综述的信息。句①～③从两个方面（*value of the ecosystem services* 和 *the function and service*）展开的。这不仅是基于文献的个人总结，也是以此为依据，对已有文献的整理和遴选。句中通过使用 *Several researches*、*In particular* 和 *Furthermore* 等词，表达出一个层层递进的逻辑关系。使用陈述句，也表达出对已有成果的肯定。句④～⑥话锋一转，连用 *However*、*Moreover*、*Although* 三个词，强调了前期研究中存在的局限性（*complicates the calculation process*，*difficult to unify the parameter standards* 以及 *different emphasis*、*limitations of the parameter adjustment*）。进而总结出，这些局限导致“*this method is not preferable*”、“*inaccurate results*”等 knowledge gaps。请注意，表述局限性过程中，选用了一些标识性词/组，如“*difficult to*”、“*only*”、“*limitations*”等。本段看似与第一段中提到的降尺度方法研究流域生态系统服务没有明显的关联逻辑，但恰恰是为了强调研究流域尺度的可行性及采用降尺度方法研究的必要性，并由此引出第四段内容：

①*With the development of ecosystem service research*, *the downscaling method with a correction factor was adopted to modify the value of the ecosystem services in China and worldwide*. ②*For example*, *by examining the association be-*

tween ecosystem services intensity (ESI) and land use and land cover change (LULCC) from a spatial perspective at the county level (Chen et al., 2019), and adjusting the "unit area of ecosystem services value of China's terrestrial ecosystem" by vegetation net primary productivity and the ability and willingness to pay into the county level (Aschonitis et al., 2016). ③Additionally, the values of small-scale ecosystem services such as at the province-scale (Chen et al., 2020) and county-scale (Guo et al., 2001, Chen et al., 2019, Cui et al., 2019) were obtained. ④However, neither of these values can accurately reflect the regional heterogeneity and the joint influence of the natural and anthropogenic factors (Mengist et al., 2020). ⑤In particular, in the case of ecologically fragile areas, in which mountainous hazards occur frequently, there exists spatial and temporal heterogeneity and differences in the payment for the ecosystem services in different regions and scales (Zhang et al., 2010, Chen et al., 2019, Mengist et al., 2020). ⑥Consequently, the valuation of watershed ecosystem services encounters the challenges of reflecting the imbalance of the spatial distribution, modifying the value equivalent factor in a unit area taking into account the regional vulnerability indicators, and reflecting the synergistic impact of natural and human factors (Trabucchi et al., 2012).(引言第四段)

句①在逻辑上又绕回到了第一段——采用降尺度方法修正生态系统服务的量化。句②～③是综述。句④又以"*however*"开头,道出研究局限性。句⑤用"*In particular*"予以补充,将研究对象进一步缩小到"*ecologically fragile areas*",完成了紧扣主题。句⑥总结了当前研究中面临的挑战,即 knowledge gap,从而突出了研究的创新点。

(3)研究的目标、方法和价值/意义

此部分着重在提出前人没有解决问题的基础上,概述性描绘本研究的目标、方法、价值和意义等,如例 5 所示。

5. *Ethnic and locational differences in ecosystem service values: Insights from the communities in forest islands in the desert*[①]

①The main objectives of this study were: (i) to determine if ethnicity and location (defined as spatially separated mountains) affect ES identification and ranking, and (ii) to assess if ethnicity and location affect the selection of most important plant species for different ecosystem services. ②As study area we selected three forest islands in the arid lands of northern Kenya. ③These forest islands are seasonal and dry-spell cattle grazing stations, and their conservation is a challenge. ④As already reported in 1961, *'the problem [of protecting northern Kenya forests] is not a small one; short of employing an army of forest guards,*

① Cuni-Sanchez A, et al. Ethnic and locational differences in ecosystem service values: Insights from the communities in forest islands in the desert. Ecosystem Services, 2016, 19: 42-50.

it would be impossible to protect these forests from damage or destruction by an unwilling population' (*KNA*, 1961). ⑤*For example*, *in one of the forest studied*, *which is an important elephant habitat in northern Kenya* (*Ngene et al.*, 2009), *ten plant species are red listed by IUCN and deforestation and forest degradation are major problems*, *mainly linked to firewood harvesting and increased demand for agricultural land for food production* (*Shibia*, 2010; *Githae et al.*, 2008). ⑥*Through this case study in northern Kenya*, *we aim at highlighting gaps in current ES research and show how one could address these gaps*, *not only in northern Kenya*, *but elsewhere in the world*.(引言最后一段)

句①"*The main objectives of this study* "开宗明义的给出了研究之目标。句②"*As study area we selected*"指明了研究区。句③～⑤是对研究区选择依据和特征的基本描述。句⑥"*Through…*,*we aim at …*"用于陈述研究之目的。此例写的干净利落,没有一丝拖泥带水之嫌。

(4)反复修改并检查

完成引言撰写后,应当对其反复检查和修改。修改大致包括两种情形:一是引言撰写完成后,需要梳理前后文的逻辑,使之保持一致;二是在正文 full text 成稿后、选定目标期刊投稿前,根据目标期刊撰写要求,对引言再进行一次逻辑上的检查和修订。

三、案例赏析

为进一步加深对引言结构和逻辑组织的理解,又选取了三篇论文的完整引言部分,通过逐句的逻辑分析,以期加深初学者对引言写作模式及一些写作技巧的体验感。

6. *Optimizing land use patterns for the grain for Green Project based on the efficiency of ecosystem services under different objectives*[①]

①*Ecosystem services are the natural environmental conditions that form and maintain an ecosystem as well as the ecological processes on which humans depend for their survival* (*Daily*, 1997). ②*The conceptual framework of the Millennium Ecosystem Assessment identifies the main component of ecosystems as human beings*, *and human activities directly or indirectly change ecosystems*, *thereby further impacting human well-being* (*Assessment*, 2005). ③*Since the implementation of the western development policy*, *the economic and social development of the Guanzhong-Tianshui Economic Zone has been rapid*. ④*However*, *with economic growth and population expansion*, *a large amount of land has been occupied*, *carbon emissions have sharply increased*, *the demand for food production has increased*, *and soil erosion has become more severe*. ⑤*Human activities targeted at economic development have changed the structure and function of ecosystems*, *re-*

① Zeng L, et al. Optimizing land use patterns for the grain for Green Project based on the efficiency of ecosystem services under different objectives. Ecological Indicators, 2020, 114: 106347.

sulting in the weakening of ecosystem services. ⑥*To effectively control the scale and intensity of human activities, it is essential to study the impact of human activities on ecosystem services and the interactions among ecosystem services* (*Zheng et al.*, 2003).(引言第一段)

引言首段句①从"人类赖以生存(*on which human depend for their survival*)"的话题入手。入手话题关乎人类生存,不可谓不重要。句②紧跟着道出观点"人类是生态系统的主要组成部分,人类活动直接或间接改变着生态系统,从而影响着人类福祉"。这一接,真是来神之笔,既收敛了范围,又进一步明晰了主题,即"人类活动通过改变生态系统影响自己的福祉"。句③~⑤介绍了一个案例,是对句②的实证解释。句⑥逻辑上紧跟句②,收敛范围,并以"*the interactions among ecosystem services*"结尾。

①*The interaction among ecosystem services can be divided into trade-offs and synergies* (*Bennett et al.*, 2009). ②*Qin et al. considered that grain supply and water production had a synergistic relationship, as did soil conservation and carbon sequestration, and that water conservation and grain supply had a strong trade-off relationship* (*Qin et al.*, 2015). ③*Tian et al. found that water yield and sediment yield were synergistic, while net primary productivity* (*NPP*) *had a trade-off relationship with water yield and with sediment yield in Karst areas* (*Tian et al.*, 2016). ④*Scenario simulation is an effective tool for exploring trade-offs and synergies among ecosystem services, and studying the relationship between ecosystem services under different land use scenarios has become an important research subject at home and abroad* (*Liu et al.*, 2017; *Wu et al.*, 2018; *Butler et al.*, 2013; *Gren et al.*, 2009; *Lautenbach et al.*, 2017).(引言第二段)

第二段句①以首段尾句相同的词语"*the interactions among ecosystem services*"起首,这是逻辑上非常好的一种承上启下方式。难能可贵的是,通过引用文献(*Bennett et cl*,2009)开门见山地指出"*interactions*"具有权衡协同关系(*trade-offs and synergies*)。有心的读者会发现,依然是这一句话,再一次成功的实现了收敛范围的目的。句②~③是对句①权衡协同关系(*trade-offs and synergies*)观点的佐证。尾句则指出了,情景模拟是"*interactions*"研究中的有效工具和重要主题。

①*However, the current research on land use scenarios primarily focuses on the modeling and simulation of land use processes* (*Hu et al.*, 2007). ②*These studies generally have the limitation of a small number of land use scenarios as well as uncertainty in the selection of land use impact factors, which makes it difficult to fully assess all potential land use scenarios.* ③*This limitation will therefore affect subsequent research on the relationships among ecosystem services.* ④*Furthermore, although the above studies analyzed the interaction among ecosystem services and the impact of land use change on ecosystem services, they did not optimize the spatial distribution of land use according to the efficiency of ecosystem services under different objectives.* ⑤*In other words, assuming that the eco-*

system services provided by the natural environment in a certain region are constant and there are trade-offs and synergies relationship among ecosystem services, how to optimize the spatial distribution of land use to maximize the target ecosystem services under different ecosystem services is what we need to explore.（引言第三段）

第三段中，“*However*”作为首句开头，具有明显的转折语义，表达出了与第二段内容不同的信息。“*However*”使用地非常好，很醒目。同句中，“*primarily*”和“*focuses on*”为前期研究中的局限性或 knowledge gap 进行了铺叙。事实上，句②中出现的 *limitation* 作为承接，不仅指出了具体局限是什么（*limitation of*），还指出局限的影响（*makes it difficult to fully*，特别是 *fully* 这个词）。句③④接得非常好，从两个不同的视角，解释了研究这一局限的重要意义。句⑤以“*In other words*”开头，很清楚是在重复前四句内容。怎么重复的呢？这就是技巧。当读者看到，句子以“*what we need to explore*”结尾，便会明白论文把 *limitation* 转化为了 *research question*。这种写作技巧很值得初学者模仿。

①*Bayesian belief network* (*BBN*) *is a probabilistic knowledge representation and reasoning model* (*Landuyt et al.*, 2013). ②*It visualizes abstract and pluralistic knowledge through nodes and directed edges, and implies causality and conditional correlation between nodes* (*Landuyt et al.*, 2016). ③*The structure of BBN is flexible, which makes it possible to add or delete network nodes and modify the network connection relationship according to actual cases.* ④*The features of BBN make it applicable to the field of ecosystem service simulation, and provides decision support for policy formulation and evaluation* (*PérezMiñana*, 2016). ⑤*Some researchers have adopted the research model of combining BBN with ecosystem service simulation* (*Gonzalez-Redin et al.*, 2016; *Dal Ferro et al.*, 2018; *Dang et al.*, 2018). ⑥*However, the breadth and depth of the future applications of this research model need further exploration, for example, applications in scenario analysis.*（引言第四段）

第四段中，句①开门见山、没有任何拖泥带水地指出，BBN 是一种 model。这是向读者介绍研究中将要采用哪一种研究方法的表述方式。这一段在思路上与前三段跳脱，也是一种写作技巧，供初学者思考体会。句②通过引用介绍了这种方法的优点。请注意，句①和句②主语是一致的，前者使用了 BBN，后者使用的 it。此处，没有将两句话合并为一句话，而是遵循写作中“语句从简”原则，很值得非英语母语者借鉴。句③介绍了 BBN 结构特征，意在解释；更重要的是，为句④铺垫。句④在介绍 BBN 适用范围和用途的同时；通过引用也在强调该方法适合于本研究。句⑤除了证实引用真实性的同时，也通过引用了三篇新文献，表明采用这种方法的研究是具有基础的。三篇新文献集中在一起，旨在强调它们是最新成果，是跟踪研究前沿。注意，这里的引用方法，旨在强调“谁，在做什么”，丝毫没有对这三篇文献研究内容进行深究的意图。为什么呢？因为，句⑥起首词就是 *However*。句⑥中的“*However*”作为本段最后一句话的起始，其目的此时已经呼之欲出了。就是要指出，以上研究前沿成果中尚存在不足。所以，以上三篇最新文献中“得到了什么结果”根本不是重点。同样，在“*however*”之后，文中没有任何拖泥带水，直接使用了“*breadth*”和“*depth*”两个词，清晰地点出当前研究存在的不足。此外

还通过使用“*future*”和“*further*”分别强化了“*applications*”和“*exploration*”。很明显，使用“*breadth*”和“*depth*”，一方面是为了吸引更多的关注；另一方面是出于分析理论框架的构建。本文真正要研究的内容，就隐含在这个框架中，即句尾的“*for example, applications in scenario analysis*”。

①*In this paper, BBN is introduced to simulate three ecosystem service processes: grain supply, carbon sequestration and soil conservation.* ②*Taking natural environment, population change and policy planning as indicators, we designed land use scenarios.* ③*Then, the probability distribution and the interactions among different ecosystem services under different land use scenarios are predicted through BBN.* ④*Finally, the spatial layout optimization scheme for land use is formulated according to the efficiency of different ecosystem services objectives.*（引言最后一段）

引言的最后一段逐一介绍了研究的内容、基本实验设计以及结果是什么，属于常见模式化表述方法。

7. *Designing a network of green infrastructure for the EU*[①]

①*There is increasing global concern about the fast degradation of ecosystem services (ESS) and the rapid decline of biodiversity (MEA, 2005; WWF, 2018).* ②*The recent assessment on biodiversity and ESS by the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) warns that nature across most of the globe has been significantly altered by multiple human drivers, with the great majority of indicators for ecosystems and biodiversity showing rapid decline (IPBES, 2019).* ③*The deterioration of natural ecosystems threatens the persistence of more than 25% of all species, many in risk of extinction within decades, and the future maintenance of ESS they support (Duffy, Godwin, & Cardinale, 2015)* ④*All these changes also compromise future human wellbeing.* ⑤*In the EU, Maes, Barbosa, and Baranzelli (2015) reported declines in ESS of 5.2% delivery compared to 2010.* ⑥*Under these scenarios, there is an urgent need for conservation efforts to halt the degradation of ecosystems and foster the sustainable use of multifunctional landscapes.* ⑦*This requires adequate planning to help harmonizing biodiversity conservation and maintenance of ESS with other legitimate societal objectives competing for limited space and resources (UN General Assembly, 2015).*（引言第一段）

引言首段首句从生态系统服务(*ESS*)和生物多样性(*biodiversity*)快速退化(*fast degradation*)这一全球性问题引入了一个宽泛的话题，来吸引读者的注意。句②是对退化情况的补充说明。句③～④话通过严重后果，意在突出了研究的重要性。句⑤将问题从全球收敛到了

① Hermoso V, et al. Designing a network of green infrastructure for the EU. Landscape and Urban Planning, 2020, 196: 103732.

研究区欧盟。句⑥～⑦提出解决问题办法——采取保护措施“*adequate planning*”，指明了研究意义。“*planning*”对应的是题目中的“*Designing*”。看完第一段，是不是感觉并未直奔主题，似乎可有可无？别急，让我们来看第二段：

①*In response to the rapid decline of natural ecosystems, the EU has developed policies focused on securing sustainable provision of ESS, the protection of natural capital and the development of strategies to cope with potentially changing conditions in the future (e.g. climate change; Maes, Barbosa, et al., 2015).* ②*However, management of natural ecosystems cannot be restricted to areas within PAs' borders.* ③*Integrated planning for biodiversity and ESS beyond PA boundaries seems unavoidable because species' are expected to shift their distribution ranges under climate change, potentially reducing the effectiveness of current conservation efforts within PAs (Araújo, Alagador, Cabeza, Nogués-Bravo, & Thuiller, 2011).* ④*In this line, the EU in 2013 laid the foundations to create a network of Green Infrastructure (GI) (European Commission, 2013a).* ⑤*This network of GI is viewed as a "strategically planned network of natural and semi-natural areas designed and managed to deliver a wide range of ESS and stop the loss of biodiversity" (European Commission, 2013a).* ⑥*Two key objectives guide the designation of this network: i) to enhance connectivity between PAs to allow species to thrive across their entire natural habitat, and adapt to effects of climate change, and ii) to contribute to the maintenance of ESS delivery to society.* ⑦*The Natura 2000, the network of PAs in the EU, is the backbone of this network of Green Infrastructure.* ⑧*New areas must now be strategically added to connect PAs and foster landscape multifunctionality (European Commission, 2013a).* ⑨*Recognizing that the matrix in between protected areas also have conservation value and managing it accordingly is key to achieve the aims of the EU Biodiversity Strategy, of halting biodiversity loss (European Commission, 2011; Hermoso, Morán-Ordóñez, Canessa, & Brotons, 2019).*（引言第二段）

第二段句①指出，为应对自然生态系统退化制定了一些政策，呼应了第一段中提及的保护措施。句②以“*However*”开头，指出了当前自然系统管理中存在的问题，这种极具戏剧特点的词语很容易引起读者的好奇心，加之“*cannot*”的出现，读者一探究竟的欲望完全被激发出来了。句③是对句②的解释，指出自然系统管理不能局限于保护区边界的原因。这里再一次出现了第一段中反复出现的“*biodiversity*”和“*ESS*”，使得第一段的立意逐渐明朗。句④中考虑“*biodiversity*”和“*ESS*”的综合规划是建立绿色基础设施网络（*network of GI*）的前提。恍然大悟啊！至此，本文研究主题终于从“*biodiversity*”和“*ESS*”退化这一一般性问题聚焦到了“*network of GI*”具体问题上。句⑤～⑥用于说明“*network of GI*”的概念及设计网络的两个目标——加强保护区之间连接和维持生态系统服务供应。怎么来实现这两个目标呢？句⑦～⑧给出了答案，即增加新的区域来连接保护区并提升景观的多功能性。在句⑦中，可以发现欧盟在 2013 年奠定的基础是“*Natura* 2000”。句⑨提出了生物多样性保护的另一个关键“*Rec-*

ognizing that the matrix in between protected areas”，实则是一个过渡句。

①*Given potential conflicts between different interests on a highly populated landscape where there is high competition for land between different uses* (*e.g. urban*, *agriculture*, *conservation*), *strategic decisions are unavoidable* (*Verhagen*, *van der Zanden*, *Strauch*, *van Teeffelen*& *Verburg*, 2018). ②*The integration of these multiple objectives can be explicitly addressed through spatial planning tools to minimise potential their conflicts and enhance co-benefits* (*Howe*, *Suich*, *Vira*, & *Mace*, 2014). ③*In the EU*, *large scale planning exercises have been carried out to identify priority areas for biodiversity conservation* (*e.g.*, *Kark*, *Levin*, *Grantham*, &*Possingham*, 2009; *Kukkala et al.*, 2016) *or securing access to ESS* (*e.g.*, *Vallecillo et al.*, 2018; *Maes*, *Paracchini*, *Zulian*, *Dunbar*, & *Alkemade*, 2012). ④*However*, *the integration of these two objectives simultaneously in a single planning exercise has only been carried out at smaller scales* (*e.g.*, *Domisch et al.*, 2019; *Lanzas*, *Hermoso*, & *de-Miguel*, *S.*, *Bota*, *G.*, &*Brotons*, *Ll.*, 2019; *Barbosa et al.*, 2019). ⑤*Therefore*, *there is still a knowledge gap on how to design this strategic network of GI that pursues ESS and biodiversity conservation objectives at the EU level*.（引言第三段）

第三段句①由不同土地用途导致的利益冲突，引出“*strategic decisions are unavoidable*”。这里，土地用途承接了上一段中提到的“*matrix*”，可见上下文的逻辑之严密。句②指出，空间规划能够实现多目标整合，减少冲突并提高共同利益，这里的 *spatial planning tools* 即上句中的 *strategic decisions*。句③～④是文献综述。句③肯定了欧洲在大尺度上分别开展了以实现生物多样性保护或者生态系统服务为目标的规划。到了句④又是用“*However*”开头，并辅以“*only*”指出当前研究的局限性，即同时结合这两个目标的规划只在小尺度开展的。基于前文的铺垫，句⑤直接指出了 knowledge gap，即在欧盟层面上设计同时考虑 *biodiversity* 和 *ESS* 的 *network of GI*。

①*Here*, *we demonstrate how a spatial planning tool - based on the identification of clear conservation and ESS objectives - can be used to design a comprehensive*, *multi-objective network of GI across the EU to enhance connectivity among PAs and warrant the provision of ESS*. ②*We assess the implications of the setting GI priorities at different policy scales* (*national vs continental*). ③*For this*, *we tested two alternative scenarios for planning this network of GI*: *an EU-based scenario*, *where the full GI network is planned at the continental level*, *and a countrybased scenario*, *where separate GI planning exercises are carried out for each EU member state*. ④*We evaluate the pros and cons of each scenario and provide guidance on how systematic planning could be used to design a future network of GI in the EU*. ⑤*With this exercise we intend to provide tools to future integrated planning for multifunctional landscapes*, *which has been long demanded in EÚs policy* (*EEA*, 2014). ⑥*We used the best available data on distribution of verte-*

brates, habitats and ESS at the continental scale and integrated them in a prioritisation exercise to identify new management areas outside the current N2000 network that could help achieve the two-tiered objective of the EU GI network.（引言第四段）

第四段作为引言最后一段共有六句话，分别交代了研究内容、研究方法、研究目的以及研究意义。

8. *Enhancing ecosystem restoration efficiency through spatial and temporal coordination*[①]

①*Habitat loss and fragmentation are leading drivers of declining biodiversity and ecosystem services worldwide* (1－3). ②*Landscape corridors and dam removals are popular and effective strategies for mitigating fragmentation* (4, 5). ③*To implement these projects efficiently, societies around the world are developing regional and even continental-scale plans for restoring ecosystem connectivity* (6). ④*These plans set ecosystem-level conservation objectives and identify priority regions for investment, but individual project selection* (*e.g., a specific dam removal or habitat corridor*) *is generally dictated by opportunism and politics.* ⑤*When poorly coordinated, these piecemeal mitigation efforts may be an inefficient means of achieving ecosystem-level objectives.* ⑥*Transboundary coordination is known to increase the cost-effectiveness of nature reserve networks* (7－9), *but the benefits of coordination are likely to be even greater for connectivity efforts in rivers because the dendritic nature of drainage basins makes them highly susceptible to fragmentation* (10－12). ⑦*Migratory fishes, which support major fisheries and ecosystem processes, are particularly vulnerable to life cycle disruption by the millions of dams and road crossings that fragment the world's rivers* (13, 14).（引言第一段）

引言首段句①紧扣主题，直截了当指出生境破碎化是生态系统服务和生物多样性减少的主要驱动力，并用“*worldwide*”突出了问题的重要性、交待了研究背景。句②紧接着给出了缓解破碎化的有效策略。该句的重要意义在于将研究范围限定在“*Landscape corridors*”和“*dam removals*”。句③～④介绍了当前世界范围内恢复连通性的一些做法及其局限性。这里*but*作为关联词，采用先肯定再否定的方式指出现有规划存在的问题，这是非常值得我们学习的一种写作技巧。句⑤用“*when*”开头作出假设，强调协调的重要性，研究主题进一步收敛。句⑥提出“*Transboundary coordination*”这一概念，呼应了题目中的“*spatial coordination*”，同时把研究对象限定到了“*rivers*”。句⑦用“*which*”引出“*Migratory fishes*”，既指明了研究选择的焦点物种，又给出了选择依据。

①*Here, we investigate the value of coordinating restoration efforts in space*

① Neeson T M, et al. Enhancing ecosystem restoration efficiency through spatial and temporal coordination. Proceedings of the National Academy of Sciences of the United States of America, 2015, 112(19): 6236-6241.

and time to maximize ecological connectivity between the Laurentian Great Lakes and their tributaries. ②*The Great Lakes Basin (GLB) contains 21% of the world's surface freshwater and is home to more than 33.5 million people* (15). ③*High societal dependence on lake-derived ecosystem services includes US$ 7 billion annually in economic activity related to recreational fishing* (16). ④*Historically, breeding migrations of dozens of native fish species formed an important ecological link between the Great Lakes and their tributaries* (17). ⑤*Today, hundreds of thousands of dams and road culverts partially or fully block historical fish migration routes* (18). ⑥ *There is growing investment in removing or modifying these structures, but project selection has been largely opportunistic and driven by local priorities.*(引言第二段)

第二段句①承接上文,同样紧扣时空协调(*coordinating … in space and time*)这一主题,并指出了本文的研究区。句②～⑤介绍了研究区的基本特征及选择依据。句⑥陈述了大坝拆除的现状和限制因素。这里的"*priorities*"与题目中的"*temporal coordination*"对应。

①*Barrier removal projects to restore tributary connectivity are selected and funded by a diverse set of actors operating independently at different spatial scales across the GLB.* ②*Most road crossings are managed by counties or states, whereas impacts of dams are addressed at the watershed, state, federal, or even international level.* ③*Funding to restore connectivity is often disbursed as small, one-time investments, but large pulses of public investment are occasionally available, as within the $1.2 billion Great Lakes Restoration Initiative* (19). ④*Although connectivity restoration efforts have been piecemeal, the GLB has a long history of collaborative management of shared resources, including binational treaties regarding fisheries, invasive species, and water quality* (20). ⑤*The success of these initiatives demonstrates that large-scale coordination is feasible and that large pulses of spending can be arranged when justified.*(引言第三段)

第三段从时空两个尺度交待了研究区大坝移除工作状况。句①②在于反映空间上河流连通性的重建工作与其发挥作用的尺度不相匹配。句③侧重介绍时间上的资金投入阶段。句④⑤通过举例证明大尺度下空间协调措施是可行的。

①*We used a return-on-investment framework to analyze potential efficiency gains from coordinating barrier removals at a range of spatial scales (county, tributary, state, lake, nation, or GLB-wide) and temporal scales (a single "pulse" of investment vs. the same amount allocated as a series of 2, 5, or 10 "trickle" investments).* ②*Return-on-investment approaches are known to outperform alternative strategies such as purely minimizing cost, and maximizing benefit irrespective of cost* (21). ③*Our mathematical optimization model identifies the portfolio of barrier removal projects that provides the greatest increase in total tributary channel length (hereafter "habitat") accessible to migratory fishes for a*

given budget. ④*Channel length serves as a surrogate for gains in spawning habitat across the entire fish community and is widely used in restoration planning in lieu of high-resolution spawning habitat maps for individual species*.（引言第四段）

第四段是对研究方法的介绍。句①承接了上一段的尺度逻辑，细化了本文研究的时空尺度。句②介绍了“*return-on-investment framework*”较其它方法的优越性。最后两句话则是介绍研究采用数学模型的大致情况。

①*We applied this model to a comprehensive barrier inventory for the GLB, encompassing* 6,692 *dams and* 232,068 *road crossings georeferenced within the* 661 *largest tributary watersheds* (18). ②*For each of these structures, we estimated the direct economic cost of restoring full passability* (*removal of dams or retrofitting road culverts*) *and the net upstream habitat that would become available, and we used estimates of the current passability of each culvert* (22). ③*Barrier passability is defined as the proportion of fish able to pass through or over a barrier to migrate upstream*. ④*Because dozens of partially passable structures often separate headwater spawning grounds from the Great Lakes, we calculated the net probability that a migratory fish could reach the area upstream of a particular barrier as the product of that barrier's passability and the passability of all downstream barriers* (*hereafter, the “cumulative passability” of a barrier*). ⑤*Similarly, the net benefit of any barrier removal includes not only full access to the unobstructed area immediately upstream but also partial access to areas above successive upstream barriers until cumulative passability declines to zero*.（引言最后一段）

引言最后一段主要介绍了模型在本研究中的应用情况。

四、常见问题

引言撰写过程中，初学者时常会犯一些共性错误。现在总结如下，希望读者们能够引以为戒：

(1)内容过于简单，在强调研究重要性方面有余，但是在归纳和总结前人取得的成果方面不足。(2)引用参考文献或是较为陈旧或是数量偏少或是质量良莠不齐。其核心问题无外乎或是文献检索不到位，或是文献阅读量不足。(3)只罗列文献而不总结，写成了“流水账”，缺乏系统观点及研究创新输出。

第三节　思考与练习

一、课后思考

1. 引言是 full text 中最难写的一部分。本讲通过选用大量案例，在总结出引言常见固定写作格式的基础上，围绕着固定写作格式，为初学者提供了多视角案例的详尽剖析。希望在这

个往复过程中，加深初学者对引言写作格式的印象，初步掌握引言撰写基本方法。

初学者要通过反复阅读和思考，明白一件事，这就是施一公院士在博文中再三强调的，逻辑 logic flow 是关键，最重要。

2. 本讲遴选的案例写法差异较大，但都紧密围绕引言的基本结构展开，无一例外。为什么会存在写法差异较大的情形呢？原因很多，有主观的，也有客观的。除主观原因外，客观原因为什么会造成上述如此之大的差异呢？建议读者仔细揣摩，用心体悟。

建议初学者可以结合自己阅读文献过程中，尝试寻找一些自己喜好的文风与范文及复研读，以便加深理解和记忆，同时也以备自己在论文写作过程中模仿。

3. 本节还强调了不同引言写法的重要性。建议初学者尝试总结一下，具体写作格式所适用的场景。有必要整理、熟悉尽可能多的常用引言写作方法，不断丰富自己的写作技巧。

总之，写好引言，离不开勤加模仿、练习，以及不断地修改。请务必认清：论文是改出来的，不存在一步写到位，需要不断的 edit，edit，and more edit。

二、课后练习

1. 案例评析。尝试采用本讲开篇案例分析的方法，选择几篇本学科或研究领域内 top 期刊上已发表的论文，对其引言的逻辑性进行逐句评析，进一步提高引言写作格式的掌握程度。

2. 完成自己论文引言部分的写作。引言初稿是初学者把阅读和整理文献、探索创新乃至实验设计等诸多过程详细记录下来的劳动成果，因此一定要将其写下来。也只有在初稿形成的基础上，后期才方便修改。

如果有同学已经写完引言部分了，那么，请按照讲授的引言写作结构核查，寻找出那些还有很大提升空间的地方，并给予相应的修改和完善。再重复一遍：edit，edit，and more edit。