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“Three Country-Trusted Broker”: An Effective Public-Private Model for Orbital Debris Remediation - Part Two: Country Contracting Phases

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ABSTRACT

In Part One¹ of TCTB’s planned trilogy of papers describing its business model for active debris remediation (ADR) of high mass derelict objects in Low Earth Orbit (LEO) “owned” by China, Russia and the U. S., TCTB described a public-private “Red Cross” model for ADR that would overcome legal, political, national security, economic and funding hurdles that must be overcome before ADR of those objects can be accomplished. TCTB’s “separate but interdependent” business model is built on the premise that if China, Russia and the U. S., who are collectively responsible for virtually all high-mass debris in LEO (risk), and the largest users of space for scientific, commercial and military purposes (opportunity), could each independently establish separate commercial contracts with the same private entity, effective cooperation and cost-sharing could be achieved through contractually established funding controls and other contractual mechanisms, avoiding some (but not all) bureaucratic complexities and delays otherwise found in direct, face-to-face international relations among sovereign states.

¹ [“Three Country-Trusted Broker”: An Effective Public-Private Model for Orbital Debris Remediation](#), C. Dickey (2019). See TCTB’s website, threecountrytrustedbroker.com, for additional information about TCTB and its plan for ADR.

Part Two describes TCTB's eight contracting Phases and procurement plan to remediate high-mass debris in LEO, embodying universal principles of transparency, economy, best procurement practices and competition. Part Two explains why funded procurement planning for ADR must begin now in the countries who own the risk of orbital debris and the opportunity of ADR, in parallel with maturing world-wide technical developments, if meaningful, cost-effective remediation is to occur before the next inevitable collision. Part Two further explains why single country ADR would be ineffective to reduce risk.

Part Three, planned for publication in mid-2020, will address the eleven contract clauses common to each participating country contract with TCTB. Those clauses serve to ally each separate country contract to a common purpose, while preserving national sovereignty and overcoming hurdles to ADR. (TCTB also plans a paper on object selection for ADR in the near future.)

Part One of TCTB's trilogy described the Proposals submitted by TCTB to China, Russia and the U. S. to begin preparing for ADR. TCTB's progress with countries will be updated in Parts Two and Three.

Introduction

From technical and economic viewpoints, orbital debris is “an accident waiting to happen”.² A world-wide, country-agnostic technical consensus has emerged that remediating many of the thousands of high mass derelict objects in LEO is required to meaningfully reduce the risk of future collisions among them.³ Numerous public or private ADR technologies capable of tackling these objects exist or are being developed across the globe.⁴ The next collision could happen at any time.⁵ If not prevented, future

² The cascading nature of orbital debris was first described by D.J. Kessler and B.G. Cour-Palais in ["Collision Frequency of Artificial Satellites: The Creation of a Debris Belt"](#), *Journal of Geophysical Research*, Volume 83, pp. 2637-2646 (1978). An economic “Kessler syndrome” can be posited from increasing debris densities causing the expected marginal value of orbital activities to fall below expected marginal cost, long before a collisional cascade, as explained by Nodir Adilov, Peter J. Alexander and Brendan M. Cunningham in ["An Economic “Kessler Syndrome”: A Dynamic Model of Earth Orbit Debris"](#), *Economic Letters*, Volume 166, pp. 79-82 (2018).

³ For example, see ["Ranking and Characterization of Heavy Debris for Active Removal"](#), J. Uetzmann, et al., (2012). The exact number of objects needing to be remediated is not clear, but most “short lists” include Russian, Chinese and U. S. objects, with a few from France, the European Space Agency, Japan and India. To be clear, high mass debris in LEO is only one subset of space debris, all of which presents risk to space operations.

⁴ ["Review of Active Space Debris Removal Methods"](#), C. Priyant Mark, Surekha Kamath, *Space Policy Journal*, Volume 47, pp.194-206 (2019).

⁵ ["Collision Risk Assessment for Derelict Objects in Low-Earth Orbit"](#), Michael J. Nichols and Darren McKnight (2019).

collisions among these objects will increase the cost of future space operations for everyone.⁶

In terms of risk, Russia is responsible for the vast majority of these objects, followed by the U. S. and China, then France, the European Space Agency, Japan and India.⁷ Looking forward to humankind's future in space, many nations and international organizations, led by the U. S., Russia and China, pursue a growing number of commercial, civil and military opportunities in space which are jeopardized by these objects.⁸

However, despite unanimous acclaim for ADR of these objects, no countries have undertaken or funded **international ADR procurement planning** to join together the country stakeholders who collectively own the risk of this category of orbital debris and the opportunities that would flow from remediation.⁹ **Why has planning lagged?** Because legal, political, national security, economic and funding issues continue to hinder ADR.¹⁰ **Why is planning needed now?** Because ADR will be expensive, requiring multiple country cooperation (and cost sharing) to overcome hurdles, mitigate risk and ensure opportunity in space remains available to all humankind. The time needed and difficulty of developing a procurement plan upon which all country stakeholders can agree will overshadow the technical challenges faced by ADR.

In this regard, it is critical to understand that no single country, no matter how wealthy, altruistic, powerful or inclined to world-leadership, acting alone, can remediate enough of the high-mass objects in LEO to meaningfully reduce the risk they present. **Stated another way, single country ADR programs would be limited by international law to a subset of targets “owned” by that country, and thus each country acting alone would be unable to significantly reduce the probabilities of collisions among all remaining objects that are “owned” by other countries, unless all countries acted independently and simultaneously to remove their own debris. However, simultaneous single country ADR programs would necessarily have to rely on the good faith of other countries to follow suit, but faith is not a viable political or**

⁶ [“Economic Dynamics of Orbital Debris: Theory and Application”](#), Nodir Adilov, Peter J. Alexander, Brendan M. Cunningham (2019).

⁷ [“Intact Derelict Deposition Study”](#), Darren McKnight, Rohit Arora, Rachel Witner (2019).

⁸ [“Update on the Global Commercial Space Economy”](#), Bryce Space and Technology (2019).

⁹ Both the U. S. House and Senate have recently expressed support for ADR. The House has endorsed remediation and recognizes the international nature of orbital debris. [House Res. 116-5666](#), Sections 1001-1003 (January 24, 2020). The Senate has identified orbital debris mitigation as a “mission of national need” providing “tremendous value to the United States and the world”. [Senate Res. 116-2800](#), Section 810 (November 13, 2019). The European Space Agency (ESA) has funded research projects which could lead to ADR, no earlier than 2025, for Envisat, a French-launched high mass derelict space object. Remediation of Envisat by itself would not appreciably reduce the risk of future collisions among high mass derelict objects.

¹⁰ *Supra*, note 1.

economic strategy - single country ADR programs are realistically not an option. For these and other reasons, concerted action is necessary.

It is also important to understand that developing an economical, fair, transparent and timely ADR procurement plan involving sovereign nations, whether through direct international diplomacy or indirectly through a “Trusted Broker”, will take considerable time, not only due to the technical complexity involved, but also because developing the means for procuring effective solutions to complex national or international problems takes time, as countries know from bitter experience.¹¹ We must therefore begin now, together, in parallel with and informed by technical progress, since the next accident cares nothing for our prayers of avoidance or excusable delay.

TCTB’s “Red Cross” business model includes a thoughtful procurement plan designed to overcome the five hurdles¹² to ADR, as well as providing a way to engage country stakeholders effectively. Based on the U. S. procurement system for public contracts,¹³ the plan is built on universal principles of fairness, efficiency, transparency, competition and best business practices. It is divided into eight Phases designed to establish consensus among country stakeholders while preserving sovereignty. **Besides a sound procurement plan, TCTB’s model provides participating countries the benefits of the “United Nations” for the cost of a consultant/mediator.**

As explained in Part One of TCTB’s trilogy, the process of direct country-to-country diplomacy and international agreements or treaties would almost certainly take far longer to accomplish than TCTB’s plan, with a greater possibility of impasse or failure.¹⁴

The first six Phases of TCTB’s procurement plan represent logical, sequential steps towards ADR. These steps would be required in any ADR plan whether undertaken by separate countries or through an inter-governmental entity established for that purpose. TCTB’s Phases 1-6 are “no risk” to participating countries since each Phase is “terminable for convenience”.¹⁵ Work products (“Deliverables” in Table One below) are owned by

¹¹ For example, “Total Package Procurement” represented a failure of U. S. planning efforts to achieve cost savings in the procurement of major weapons systems. Wikipedia contributors, “[Total Package Procurement](#)”, *Wikipedia, the Free Encyclopedia* (accessed January 30, 2020).

¹² *Supra*, note 1. Legal, political, national security, economic and funding hurdles to ADR were described in Part One of TCTB’s trilogy.

¹³ The U. S. procurement system for public contracts is maintained by the Office of Federal Procurement Policy. (41 U. S. C. 1101, et. seq.) See <https://www.whitehouse.gov/omb/management/office-federal-procurement-policy/> for a general description of that system.

¹⁴ *Supra*, note 1. TCTB’s process contemplates parallel diplomacy among participating countries.

¹⁵ In TCTB’s model, each country’s right to terminate for its own convenience simply by stopping funding is more like a pocket veto than a vote since the responsibility for competitively selecting and contracting with ADR technology “subcontractors” lies with TCTB. The contracting structure developed by TCTB differentiates it from being a “mere” consultant or mediator. The nature of that role and its rationale is more fully explained in Part One of TCTB’s trilogy.

participating countries, laying a foundation for each succeeding Phase. TCTB costs and fees are relatively inconsequential through Phase 6, and are shared equally among participating countries using a simple, transparent accounting mechanism. TCTB's costs in Phases 1-6 consist of the necessary staffing and related expenses to conduct separate discussions with each participating nation to determine a consensus regarding key elements of the plan, including cost-sharing, object selection, subcontractor selection process and selection, and risk allocation, to be implemented in Phase 7 ADR operations.¹⁶

ADR costs in Phase 7 are shared by participating countries under a formula negotiated and agreed upon in earlier Phases. However, if the contracting countries reach Phase 7 and cannot finally agree on important elements of Phase 7 ADR, thus resulting in failure to fund one or more negotiated but not yet awarded Phase 7 subcontracts,¹⁷ the work accomplished in Phases 1-6 will remain for others to build upon. TCTB's costs and fees during Phases 7 and 8 will depend upon program risk to be assumed by TCTB during those Phases. Finally, it is important to note that TCTB is not a technology company and thus will not be a competitor for ADR subcontracts in Phase 7.¹⁸

Even beginning today, TCTB's streamlined plan, involving the participation of three or more¹⁹ countries, is estimated to take more than three years to reach Phase 7 ADR operations. Each Phase of TCTB's procurement plan, summarized in Table One below, is further described in this paper.

Table One

Description	Statement of Work	Duration
Phase 1 - Prime Contract "Definitization"	Negotiation of prime contracts between TCTB and each country. Deliverables include all prime contract documents.	6 months
Phase 2 - Target Identification	Development and ranking of initial ADR targets. Deliverables include the Initial Target Ranking Document.	6 months

¹⁶ TCTB's staffing plan, including local country "fellow-brokers", is further described in TCTB's website, threecountrytrustedbroker.com.

¹⁷ Under TCTB's plan, Phase 7 subcontracts awarded by TCTB to ADR technology companies are contingent upon country provided funding for ADR. Individual country decisions not to fund may arise from a variety of factors including failure to agree on cost share, target selection, risk allocation, or technical immaturity of the selected ADR technology. In such a case, reimbursement of a portion of the proposal costs of the winning bidder could be provided for in the terms of the RFP.

¹⁸ TCTB contemplates that private entities, intergovernmental organizations and countries would be eligible to bid for Phase 7 subcontracts. Countries could also subsidize domestic bidder proposals.

¹⁹ *Supra*, note 1. Besides China, Russia and the U. S., TCTB's contractual model facilitates adding other countries (e. g., France, India, Japan) or intergovernmental organizations (e. g., ESA) at any Phase.

Phase 3 - RFP Development	Development of a Request for Proposal (RFP) seeking proposals for ADR for one or more targets identified in the Initial Target Ranking Document. Deliverables include a Draft RFP.	6 months
Phase 4 - Subcontract Development	Development of the terms of the ADR subcontract. Deliverables include a Draft Model Subcontract which will be included in the RFP.	6 months
Phase 5 - Subcontract Competition	Issuing an RFP and conducting a competition among prospective subcontractors for ADR of initial targets. Deliverables include evaluation and preliminary selection of an awardee.	6 months – one year
Phase 6 - Subcontract Award	Negotiation and execution of a subcontract between TCTB and the awardee. Deliverables include a signed subcontract between TCTB and the awardee.	6 months
Phase 7 - ADR	Management of the initial awarded ADR subcontract. Deliverables include periodic Progress Reports.	1 year or more
Phase 8 - Next Steps	Follow-on ADR projects and other special projects.	Variable - TBD

Phase 1 (Prime Contract “Definitization”)²⁰

Establishing the contractual and working relationships between TCTB and participating countries is the subject of Phase 1. Cost reimbursement type contracts are contemplated whereby TCTB’s costs of working separately with each country are reimbursed – essentially one or more separate consulting contracts. Each country “prime” contract with TCTB will utilize local country contracting forms and disputes resolution mechanisms (local jurisdiction and forum). Fixed fees avoid “cost plus a percentage of cost” contracting, incentivizing efficient performance. Although Phase 1 is intended to establish the framework for two or more country cost-sharing of ADR, it is built upon separate country contracting forms and preferences.

Although not required until Phase 7, deliberations regarding country sharing for Phase 7 ADR costs and risks are expected to begin in Phase 1. Balancing the respective country risk and opportunity for Phase 7 funding purposes is potentially complex and contentious, yet is amenable to a simple pro rata solution (i. e., equal sharing among participating countries), regardless whether the negotiation takes place in a political or contractual forum. For example, Russia’s disproportionate ownership of more than half the targets could be weighed against the arguably asymmetric share of future benefits the U. S. might enjoy by making future U. S. commercial space opportunities less expensive and risky.

²⁰ Country contracts with TCTB are referred to herein as “prime contracts”. ADR technology contracts between TCTB and competitively selected technology providers are referred to as “subcontracts.”

To the extent a participating country insists on contracting with domestic entities, TCTB has begun to establish relationships with local partners (“fellow-brokers”) in China and Russia. Trust is a key element of TCTB’s “Red Cross” model. Working with domestic partners, as well as using local contracting forms and in-country forums for prime contract level dispute resolution, are designed to build trust with participating countries.

Phase 1 establishes TCTB’s role as a “Trusted Broker” in working separately with each country to achieve the consensus required for concerted ADR. **TCTB’s role in Phases 1-6 may also be analogized to a mediator’s role in finding common ground among litigating parties.**

Phase 2 (Target Identification)

Several country-agnostic target-ranking technical studies have been performed to date or are planned, identifying hundreds of specific objects for ADR to successfully reduce or eliminate a significant risk to future space operations in LEO.²¹ However, from a procurement planning perspective no one has begun to tackle the difficult questions regarding initial object selection among this universe, how to group objects for individual remediation missions,²² and in what order they should be remediated.²³ When viewed from a procurement perspective, the best answers to these questions may depend on non-technical factors such as overall economic efficiency across more than one ADR mission.

Moreover, answers to these object selection questions will in turn lead to further questions, the subject of Phases 3-6, including which particular ADR technology should be employed for each mission,²⁴ who should pay and how much, how to select ADR technology and companies for missions (i. e., utilizing a competitive, domestic or sole source procurement process), the terms of those ADR contracts, who would make those choices, and what evaluative criteria would be applied to make the selections. All of these complex, politically charged procurement process questions must be answered before ADR in any multi-national context, whether public or private in nature, can begin. TCTB’s process is designed to establish a workable framework for answering all these questions, laying a foundation for efficient and expeditious ADR across the universe of high mass targets in LEO.

²¹ *Supra*, note 3.

²² Some technical work is being done in this area. Most relevant technical studies have suggested multi-target missions of three to eight targets.

²³ Some technical work is being done in this area. Efficient target grouping for ADR purposes will undoubtedly include targets owned by more than one country, within a framework of multiple RFPs, since relevant factors for grouping include orbit, inclination and orbital state, not ownership. Conversely, grouping targets by ownership will increase everyone’s costs.

²⁴ A number of entities, public and private, have indicated ongoing development or testing of ADR technology, which includes ground and space-based lasers, magnets, ion beams, tethers, sails, expanding foam, dust, space tugs, propulsion modules, grappling arms, nets, puffs (ADR includes orbit changing or lowering, not just deorbiting), harpoons and hooks.

Since the universe of targets are “owned” by different countries, lie in different orbits, inclinations and orbital states,²⁵ and since multiple missions are contemplated, the first step in Phase 2 must be to select a subset of objects large enough to include candidates from all participating countries (desirable) but less than the universe, or “market”²⁶, of perhaps one thousand or more potential objects. Accordingly, TCTB’s Phase 2 contemplates employing either a “dream team” of internationally respected scientists to identify a short, multi-mission list of approximately fifty to one hundred targets owned by the participating countries, or a separate country-by-country nomination process whereby each participating country would select twenty to thirty-five of its own objects for inclusion on an Initial Target Ranking Document (ITRD). This resulting list of objects is larger than the expected single mission quantity to stimulate the submission of a wide range of creative multi-target mission plans and proposals from a number of competitors. It is large enough to include targets from more than one country, but is less than the entire market of targets to avoid introducing too many variables and unnecessary complexity in the selection process.

Phase 3 (RFP Development)

Using the ITRD developed in Phase 2, TCTB and participating countries will begin to prepare one or more RFPs seeking bids for ADR of one or more potential objects on the ITRD. Using the U. S. Federal Acquisition Regulation (FAR) as a guideline, acquisition planning, leading to development of a “best value” world-wide competition among bidders is envisioned, encouraging technical maturity, low risk, creativity and efficiency. TCTB’s process would stimulate commercial space growth across the globe.²⁷

To avoid constraints on the process stemming from domestic preferences otherwise imposed by participating countries, TCTB, as the prime contractor, would be solely responsible for conducting the competition and making subcontractor selections. However, participating countries would be able to provide financial subsidies, in-kind support, and launch services to local bidders. Similarly, mandatory socioeconomic programs applicable to procurements of participating countries could be bypassed, given the private, international character of the undertaking.

Phase 4 (Subcontract Development)

²⁵ Derelicts grouped in certain orbits or inclinations have been referred to as “clusters”. Many targets exhibit unique characteristics such as tumbling that could complicate grouping of targets for ADR missions.

²⁶ “Market” has antitrust implications that would become relevant during Phases 6 and 7 subcontractor selection and ADR operations. Favoring competition is a universal element of virtually all national and international procurement systems.

²⁷ In particular, TCTB’s plan would stimulate each participating country’s domestic commercial space industry. As to the universal importance of commercial space growth across the world, see, for example in Russia, V. B. Uvarov, “[Increasing the Efficiency of the Use of the ISS: Modern Approaches towards Commercialization of Space Experiments](#)”, *Space Research*, Vol. 4, pp. 252-261 (2017) (DOI: 10.7256/2453-8817.2017.4.25023).

Simultaneously with RFP development, TCTB and participating countries will begin to prepare terms and conditions for a model subcontract to be included in RFPs, which would then be negotiated and awarded to the selected bidders as a result of the competitions. Firm fixed price subcontracts are envisioned, but cost reimbursement provisions could be permitted depending on technology maturity, scope and other factors. End to end coverage (e. g., ground support, launch service, propulsion, proximity operations, rendezvous, docking, and de-orbit, reentry or graveyard maneuvers) is contemplated, as is assumption of all risks by the subcontractor (e. g., launch service, licenses, comprehensive all-risk all-party insurance/indemnity/cross-waivers). Given the wide range of sovereign and commercial risk allocations for different types of space projects in each participating country, developing a mutually agreeable formula for risk-sharing among all participants will be complex and time-consuming.²⁸ Other terms could also prove challenging for countries to reach accord, including data rights.

Phase 5 (Subcontract Competition)

Using the RFP and model subcontract, TCTB will advertise and conduct a world-wide competition for ADR of one or more objects listed on the ITRD, which will result in evaluation and preliminary selection of one or more awardees for negotiation of ADR contracts. Subcontractors will be expected to bear all proposal costs,²⁹ provide insurance for all parties for all risks (except to the extent country participants have authorized cross waivers or indemnities), provide all necessary licenses, and arrange for all capital needs or financing for performance. Further, subcontractors will be expected to provide intellectual property rights to TCTB and countries necessary for performance of the subcontracts and for other purposes except as limited by proprietary rights, similar to the policies for acquisition of data rights from subcontractors contained in the U. S. Federal Acquisition Regulation. As noted earlier, TCTB will select awardees for negotiation of subcontracts.³⁰

Phase 5 should attract venture capital and stimulate a commercial market for ADR, as well as help to enable development of adjacent markets such as satellite servicing, both through anticipated funding for Phase 7 projects provided by countries and by technology maturity gained through performance of Phase 7 contracts. Commercial space projects in LEO were jump-started in a similar fashion during the early 2000s by NASA through commercial crew and cargo programs for the International Space Station.

Phase 6 (Subcontract Award)

²⁸ A model risk allocation clause for inclusion in all participating country prime contracts is contained on TCTB's website. Part Three will develop the rationale for all eleven common country contract clauses. Drafts of all eleven clauses are contained on TCTB's website.

²⁹ But see note 15, *supra*.

³⁰ ADR subcontractor selection by TCTB would also insulate countries from bid protests by disappointed non-selected subcontractors.

After negotiation with selected awardees, TCTB will award subcontracts for performance of ADR projects which will be contingent on country provided funding to TCTB. Award decisions will be made on “best value” criteria, with input from countries. Multiple awards are possible. Part of the evaluation process will be to determine whether any Proposals are technically mature enough to begin work. If proposals received from prospective subcontractors in Phase 5 reveal a lack of mature ADR technology, or excessive risk, Phases 6-7 may be postponed or restructured.

If no Proposals are awardable, then participating countries and TCTB will have alternatives to consider including waiting until technology is more mature, or funding specific pre-ADR projects to further develop the technology necessary for ADR operations. It is likely that a few key technologies needed for ADR will be common across the market of all potential targets. In that case, Phases 3-6 will have served a valuable purpose by identifying gaps in technology and how to fill those gaps, as well as allying the responsible parties to pay for the work. **Aligned first as planners in TCTB’s model, participating countries will now be positioned as they should be, to accomplish ADR utilizing the right parties and technology at the right time.**

As noted in Table One, the process embodied in Phases 1-6 is expected to span more than three years, even within TCTB’s streamlined framework.

Phase 7 (ADR)

With planning accomplished and funding in place, and after selecting the best alternatives from among competing Proposals, TCTB will manage the ADR subcontracts and provide periodic progress reports to participating countries. The degree of country oversight will be as negotiated in earlier Phases, and the degree of risk assumed by TCTB for project success will affect the amount of fees charged.

Phase 8 (Adjacent Opportunities)

As part of the subcontractor proposal process in Phases 5 and 6, or during Phase 7 ADR, TCTB or its subcontractors may propose commercial or civil “adjacent” projects that could help defray country costs of ADR or open up new commercial opportunities (e. g., satellite servicing). Participating country approval would be required for adjacencies that might impact ADR, but shared savings would be possible. More fundamentally, Phase 8 recognizes that establishing a new commercial market for ADR of high mass objects in LEO would, in turn, stimulate adjacent markets.

Conclusion

The same handful of countries who own the risk of high mass orbital debris in LEO and the opportunities that flow from ADR of those objects also claim a leadership role in space. None of them can act alone to eliminate the risk of high mass debris in LEO, but none will likely act soon together directly! If those countries are to resolve this impasse and share the burdens of ADR, and also fulfill their role as leaders, they must agree upon a process for sharing the responsibility (i. e., spending the money) to achieve their shared objective.

“Three Country-Trusted Broker” is a novel precedent for international cooperation in space, using a “Red Cross” or “mediation” model. It lays out a process for ADR of high mass debris in LEO that overcomes legal, political, national security, economic and funding hurdles.

“Traveler, there is no path. Paths are made by walking.”³¹

ADR planning among responsible countries must begin today. In our polarized world of nation-states, framed by an outdated, bi-polar treaty structure, **TCTB is a clear and available path that can realistically overcome hurdles to ADR in time to avert the impending technical and economic catastrophe.**

Since submitting Proposals to China, Russia and the U. S. in May 2019 offering to undertake and facilitate collaborative ADR planning, TCTB has begun to establish contacts in all three countries for the purposes of obtaining funding for local contracts, and TCTB is seeking local partners to accommodate country desires for domestic solutions. The Proposals remain open for acceptance.

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³¹ Antonio Machado, “Proverbios y Cantares XXIX”, “Campos de Castilla” (1912).